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ONE HUNDRED AND THIRTY-NINTH SESSION

1916

VOL. XIII.— NO. 21—PART 6

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THIRTY-FOURTH ANNUAL REPORT

OF THE

New York Agricultural Experiment Station.

(GENEVA, ONTARIO COUNTY)

FOR THE YEAR 1915.

With Reports of Director and Other Officers.

TRANSMITTED TO THE LEGISLATURE JANUARY 15, 1916.

ALBANY
J. B. LYON COMPANY, PRINTERS
1916

STATE OF NEW YORK.

No. 21.

IN SENATE.

JANUARY 17, 1916.

THIRTY-FOURTH ANNUAL REPORT

OF THE

BOARD OF CONTROL OF THE NEW YORK AGRICULTURAL EXPERIMENT STATION.

STATE OF NEW YORK:

DEPARTMENT OF AGRICULTURE,

ALBANY, *January* 17, 1916.

To the Legislature of the State of New York:

I have the honor to submit herewith the Thirty-fourth Annual Report of the Director and Board of Control of the New York Agricultural Experiment Station at Geneva, N. Y., in pursuance of the provisions of the Agricultural Law.

I am, respectfully yours,

CHARLES S. WILSON,

Commissioner of Agriculture.

NEW YORK AGRICULTURAL EXPERIMENT STATION.
W. H. Jordan, *Director*.

Geneva, N. Y., *January* 12, 1916.

Hon. Charles S. Wilson, *Commissioner of Agriculture, Albany, N. Y.:*

Dear Sir: I have the honor to transmit herewith the report of the Director of the New York Agricultural Experiment Station for the year 1915.

Yours respectfully,
BURT E. SMALLEY,
President Board of Control.

BOARD OF CONTROL.

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Commissioner Charles S. Wilson, Albany.
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Whitman H. Jordan, Sc.D., LL.D., *Director.*

George W. Churchill, *Agriculturist and Superintendent of Labor.*
Joseph F. Barker, M.S., *Agronomist.*
Reginald C. Collison, M.S., *Associate Chemist (Soils).*
[1] Alfred J. Lewis, B.S., *Assistant Chemist (Soils).*
Everett P. Reed, B.S.A., *Assistant Agronomist.*
William P. Wheeler, *First Assistant (Animal Industry).*
Robert S. Breed, Ph.D., *Bacteriologist.*
Harold J. Conn, Ph.D., *Associate Bacteriologist.*
Godfrey L. A. Ruehle, M.S.,
James D. Brew, B.S., *Assistant Bacteriologists.*
[2] William D. Dotterrer, B.S., *Student Assistant.*
Fred C. Stewart, M.S., *Botanist.*
Walter O. Gloyer, M.A.,
[15] Forest M. Blodgett, Ph.D., *Associate Botanists.*
[3] Mancel T. Munn, B.S.,
[4] Arthur J. Mix, B.S., *Assistant Botanists.*
Lucius L. Van Slyke, Ph.D., *Chemist.*
[5] Alfred W. Bosworth, A.M.,
Rudolph J. Anderson, B.S.,
Arthur W. Clark, B.S., *Associate Chemists.*
Morgan P. Sweeney, A.M.,
Otto McCreary, B.S.,
[16] Frederick N. Crawford, B.S.,
[6] Richard F. Keeler, A.B.,
[7] William F. Walsh, B.S.,
[7] Arthur J. Flume, B.S., *Assistant Chemists.*
George A. Smith, *Dairy Expert.*
Frank H. Hall, B.S., *Vice-Director; Editor and Librarian.*
Percival J. Parrott, M.A., *Entomologist.*
Hugh Glasgow, Ph.D.,
[8] Fred Z. Hartzell, M.A. (Fredonia), *Associate Entomologists.*
Harold E. Hodgkiss, B.S.,
[9] Bentley B. Fulton, B.A.,
[10] Frank H. Lathrop, M.S., *Assistant Entomologists.*
Ulysses P. Hedrick, Sc.D., *Horticulturist.*
Roy D. Anthony, M.S.A.,
[8] Fred E. Gladwin, B.S. (Fredonia), *Associate Horticulturists.*
George H. Howe, B.S.A.,
Charles B. Tubergen, B.S.,
Joseph W. Wellington, B.S., *Assistant Horticulturists.*
Orrin M. Taylor, *Foreman in Horticulture.*
F. Atwood Sirrine, M.S. (Riverhead), *Special Agent.*
Jessie A. Sperry, *Director's Secretary.*
Frank E. Newton,
Willard F. Patchin,
Lena G. Curtis,
Agnes E. Ryan,
[11] Esther F. Hawkins,
[12] Lillian J. Freeman,
[13] Mae M. Melvin, *Clerks and Stenographers.*
[14] ——— ———, *Computer and Mailing Clerk.*

Address all correspondence, not to individual members of the staff, but to the New York Agricultural Experiment Station, Geneva, N. Y.

The Bulletins published by the Station will be sent free to any farmer applying for them.

---

[1] Appointed November 8.
[2] Appointed March 1.
[3] Absent on leave from September 30.
[4] Appointed October 1.
[5] Resigned December 31.
[6] Transferred from Department of Agronomy November 1.
[7] Appointed March 22.
[8] Connected with Grape Culture Investigations.
[9] Absent on leave from June 1.
[10] Appointed June 15.
[11] Resigned March 22.
[12] Appointed April 5, resigned October 31.
[13] Appointed November 1.
[14] Position held by Adin H. Horton until his death on December 9.
[15] Connected with Hop Culture Investigations; resigned May 1.
[16] Resigned September 20.

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THIRTY-FOURTH ANNUAL REPORT

OF THE

Board of Control of the New York Agricultural Experiment Station.

TREASURER'S REPORT.

GENEVA, N. Y., *October* 1, 1915.

To the Board of Control of the New York Agricultural Experiment Station:

As Treasurer of the Board of Control, I respectfully submit the following report for the fiscal year ending September 30, 1915:

MAINTENANCE FUND — NECESSARY EXPENSES.

APPROPRIATION 1914–1915.

1914.	*Receipts.*	*Dr.*
Oct. 1.	To balance on hand	$89 80
	To amount received from Comptroller	23,000 00
		$23,089 80

Expenditures.	*Cr.*
By real estate	$376 00
By real estate maintenance	66 41
By office equipment	136 89
By office maintenance	1,053 45
By laboratory equipment	2,428 96
By laboratory maintenance	972 72
By farm equipment	2,379 16
By farm maintenance	7,707 63
By publications	295 78
By traveling expenses	3,006 95
By miscellaneous	2,604 42
By heat, light and water	317 24
By balance	1,744 19
	$23,089 80

GENERAL EXPENSE — HEAT, LIGHT, WATER, APPARATUS, REPAIRS, ETC.

1914.	*Receipts.*	*Dr.*
Oct. 1.	To balance on hand	$3 07
	To amount received from Comptroller	5,500 00
		$5,503 07

	Expenditures.	*Cr.*
	By real estate maintenance	$1,386 09
	By office equipment	263 10
	By farm maintenance	36 70
	By farm equipment	29 25
	By miscellaneous	72 91
	By heat, light and water	3,709 95
Oct. 1, 1915.	Balance	5 07
		$5,503 07

SALARIES.

$52,000, APPROPRIATION 1914–1915.

1914.	*Receipts.*	*Dr.*
Oct. 1.	To balance on hand	$4,753 93
	To amount received from Comptroller	51,540 08
		$56,294 01

	Expenditures.	*Cr.*
	By salaries	$51,320 03
	By balance remitted to State Treasurer	220 05
Oct. 1, 1915.	Balance	4,753 93
		$56,294 01

LABOR.

$17,000, APPROPRIATION 1914–1915.

1914.	*Receipts.*	*Dr.*
Oct. 1.	To balance on hand	$771 75
	To amount received from Comptroller	16,894 37
		$17,666 12

	Expenditures.	*Cr.*
	By labor	$16,293 43
	By balance remitted to State Treasurer	600 94
Oct. 1, 1915.	Balance	771 75
		$17,666 12

SALARIES — SPECIAL APPROPRIATION.

1914.	*Receipts.*	*Dr.*
Oct. 1.	To amount received from Comptroller	$2,333 33

	Expenditures.	*Cr.*
	By salaries	$2,333 33

CHAUTAUQUA GRAPE INVESTIGATION FUND.

1914.	*Receipts.*	*Dr.*	
	To amount received from Comptroller	$7,500	00
	Expenditures.	*Cr.*	
	By real estate maintenance	$6	00
	By office equipment	5	00
	By office maintenance	62	30
	By laboratory equipment	11	51
	By laboratory maintenance	40	62
	By farm equipment	2	00
	By farm maintenance	1,742	21
	By salaries remitted to State Treasurer		08
	By traveling expenses	296	17
	By miscellaneous	101	90
	By salaries	3,799	92
	By labor	1,161	25
	By heat, light and water	29	44
Oct. 1, 1915.	Balance	241	60
		$7,500	00

FERTILIZERS, FEEDING STUFFS, ETC.
$16,000, APPROPRIATION 1914–1915.

1914.	*Receipts.*	*Dr.*	
	To amount received from Comptroller	$15,274	96
	Expenditures.	*Cr.*	
	By office maintenance	$1	20
	By laboratory equipment	505	26
	By laboratory maintenance	968	92
	By farm maintenance	7	60
	By miscellaneous	168	87
	By balance remitted to State Treasurer	486	78
	By salaries	10,635	76
	By traveling expenses	152	99
	By labor	1,482	42
	By heat, light and water	395	50
Oct. 1, 1915.	By balance	469	66
		$15,274	96

FIELD, ORCHARD AND MILK INVESTIGATIONS.

1914.	*Receipts.*	*Dr.*
	To amount received from Comptroller	$13,500 00

	Expenditures.	*Cr.*
	By laboratory equipment	$26 57
	By farm equipment	15 70
	By farm maintenance	701 44
	By salaries	8,999 88
	By balance remitted to State Treasurer	150 12
	By traveling expenses	46 95
	By miscellaneous	68
	By labor	3,524 12
Oct. 1, 1915.	By balance	34 54
		$13,500 00

INVESTIGATION OF HOPS.

1914.	*Receipts.*	*Dr.*
Oct. 1.	To amount received from Comptroller	$2,290 86

	Expenditures.	*Cr.*
	By real estate	$833 00
	By real estate maintenance	11 00
	By office maintenance	75
	By laboratory maintenance	8 15
	By farm maintenance	412 85
	By salaries	887 50
	By traveling expenses	112 54
	By miscellaneous	25 07
	By balance	....
		$2,290 86

NEW BUILDINGS.

1914.	*Receipts.*	*Dr.*
	To amount received from Comptroller	$41 88
	Expenditures.	*Cr.*
	By real estate maintenance	$5 05
	By farm equipment	36 83
		$41 88

REPAIRS TO BUILDINGS.

$1,500, APPROPRIATION 1914–1915.

1914.	*Receipts.*	*Dr.*
	To amount received from Comptroller	$1,124 07
	Expenditures.	*Cr.*
	By real estate maintenance	$1,124 07

HATCH FUND.

1914.	*Receipts.*	*Dr.*
July 1.	Balance on hand	$0 36
	To receipts from the Treasurer of the United States as per appropriation for the fiscal year ended June 30, 1915, as per act of Congress, approved March 2, 1887	1,499 64
		$1,500 00
	Expenditures.	*Cr.*
	By farm equipment	$9 68
	By farm maintenance	62 20
	By salaries	1,233 25
	By labor	194 87
		$1,500 00

ADAMS FUND.

1914.	*Receipts.*	*Dr.*
July 1.	To Balance on hand	$0 04
	To receipts from the Treasurer of the United States as per appropriation for fiscal year ended June 30, 1915, as per act of Congress, approved March 2, 1887	1,499 96
		$1,500 00

Expenditures.	*Cr.*
By salaries	$1,500 00

RING MEMORIAL FUND.

Balance on hand October 1, 1915	$1,000 00
I have received and remitted to the State Treasurer for the fiscal year ending October 1, 1915, for produce sold	$3,926 66

All expenditures are supported by vouchers approved by the auditing committee of the Board of Control and have been forwarded to the Comptroller of the State of New York.

WILLIAM O'HANLON,
Treasurer.

DIRECTOR'S REPORT FOR 1915.*

W. H. JORDAN.

To the Honorable Board of Control of the New York Agricultural Experiment Station:

Gentlemen.— In accordance with the usual custom, I present herewith the report of the operations of this institution for the calendar year 1915, together with a statement of our needs for maintenance and for additional equipment. I feel it to be my duty to place special emphasis upon the additions to equipment and funds which are essential to the progress and efficiency of the institution. The Station now sustains State-wide relations, and its work is related to agricultural products in a very definite and important way. If nothing more were taken into account than its aid in defending the farmers of the State against fungus and insect pests the investment which the State makes in the institution could but be regarded as a very profitable one. More than this, the Station has a constructive value in opening the way, slowly, to be sure, for more effective methods of handling the vast agricultural resources of the State. For all these reasons careful consideration should be given to what are its real needs if its work is to develop in accordance with the demands made upon it. Unless it is given the means of building new structures and replacing those that have outlived their usefulness, the Station will not only make no advances in its facilities but will enter upon the down grade.

ADMINISTRATION.

STATION STAFF.

The demand for men of experience and competent training from the Experiment Stations of the country and other investigational institutions brings about more changes in the Station Staff than is consistent with its welfare. The past year has been no exception in this respect:

Mr. Alfred W. Bosworth, A. M., Associate Chemist, who has been connected with the institution since May 15, 1905, resigned his position to take effect December 31st of this year to accept a research position in connection with hospital work. Mr. Bosworth's work during his connection with the Station has been chiefly devoted to the chemistry of milk and its products, and he has contributed important new facts to this field of biological chemistry. His severance from the Station is a matter of regret on the part of his associates.

---

* This is a reprint of Bulletin No. 413, December, 1915.

Frederick N. Crawford, B. S., Assistant Chemist, resigned his position to take effect September 20th in order to pursue further chemical studies.

Forest M. Blodgett, Ph.D., Associate Botanist, who had devoted his time for two years largely to the suppression of fungus troubles on hops severed his connection with the institution on May 1st. The work of Mr. Blodgett resulted in some very definite and valuable conclusions as to the control of hop mildew. It is understood that he is to continue his efforts on behalf of the New York State College of Agriculture in extending among hop growers the knowledge acquired.

On December 9th occurred the unexpected death of Adin H. Horton, who for twenty-six years had occupied a clerical position at the Station. It is fitting that I should express to you and to the public an appreciation of the faithfulness and efficiency of Mr. Horton's service to the institution. During this long period of time there was no single failure of his to attend to his duties in the most efficient and painstaking manner, unless prevented from so doing by physical disability. Such long continued, conscientious service is not so common but that it should receive special mention.

Two members of the Staff, Mancel T. Munn, B. S., Assistant Botanist, and Bentley B. Fulton, B. A., Assistant Entomologist, have been absent from the institution for a portion of the year for special advanced study. This has necessitated the filling of their places temporarily. Mr. Arthur J. Mix, A. B., a graduate of Hamilton College, and who has pursued graduate studies for a considerable period at Cornell University, was appointed to fill the place made vacant by Mr. Munn, his duties beginning on October 1st. Mr. Frank H. Lathrop, M. S., a graduate of Ohio State University, was appointed in the place of Mr. Fulton, his duties beginning on June 16th.

The vacancy caused by the resignation of Mr. Crawford has been filled by appointment of Edward J. Lewis, B. S., a graduate of the University of Michigan, who began his duties early in November.

Mr. William F. Walsh, B. S., a graduate of the University of Michigan in 1912, and Mr. Arthur J. Flume, B. S., a graduate of the

University of North Carolina in 1914, were appointed Assistant Chemists on March 22d.

THE CIVIL SERVICE RELATIONS OF THE SCIENTIFIC STAFF.

In my report for the year 1914, I called attention to the fact that the scientific staff had long ago been placed in the non-competitive class, with the exception of the Associate and Assistant Chemists. Since this report was made, I urged upon the Civil Service Commission the wisdom of placing the Associate and Assistant Chemists in the same class as the rest of the scientific staff. My request was given favorable consideration. The entire staff is now in the non-competitive class, an arrangement which is essential to the freedom of the Station management in selecting the best possible men for new or vacant positions, either from the State of New York or from outside States.

MAINTENANCE FUND.

The following were the appropriations available for the fiscal year ending September 30, 1915:

Salaries for scientific staff	$52,000
Labor	17,000
Necessary expenses of Station departments	23,000
General expense including heat, light and water	5,500
Investigations in grape culture	7,500
For field, orchard, truck, garden crops and sanitary milk investigations	14,500
Repairs, Dairy and Biological Building and forcing houses	1,500
Total	$121,000
For the analyses of samples of fertilizers, feeding stuffs, fungicides, insecticides and agricultural seeds submitted by the State Commissioner of Agriculture, and for the examination of Babcock glassware	16,000

The appropriations which were granted for the fiscal year beginning October 1, 1915, are as follows:

Salaries for scientific staff	$53,960
Labor	18,320
Necessary expenses of Station departments	23,000
General expense, including heat, light and water	5,500
Investigations in grape culture	7,500
For field, orchard, truck, garden crops and sanitary milk investigations	14,650
For the analyses of samples of fertilizers, feeding stuffs, fungicides, insecticides and agricultural seeds submitted by the State Commissioner of Agriculture, and for the examination of Babcock glassware	17,370
Grand total	$140,300

The appropriations which your Board voted as necessary for the fiscal year beginning October 1, 1916, are as follows:

General salaries of members of scientific and clerical staffs	$56,450
Services of laborers, including janitors, poultryman, engineer, herdsman, dairy helper, foreman of orchards, florist and gardener, general mechanic, watchman, teamsters, farm and other common labor	18,320
Necessary expenses of investigations, excluding salaries, but including chemicals, scientific apparatus, machinery, fertilizers, cattle foods, maintenance of working animals, traveling expenses and other necessary expenses, in conducting researches at the institution, and throughout the State in soils, plant nutrition, horticulture, diseases of plants, injurious insects, bacteriology, animal nutrition, dairy practice and poultry keeping	23,000
General expenses, including heat, light, water, general equipment and general repairs	5,500
Investigations of the conditions of grape growing in Chautauqua County and other grape-growing sections of the State, including cultivation. methods of management, fungus and insect depredations and varieties.	7,700
For conducting field, orchard and truck and garden crop investigations and demonstrations and investigating and demonstrating the means and methods of producing sanitary milk	15,300
For the enforcing of the provisions of the law in relation to commercial fertilizers, concentrated feeding stuffs, fungicides and insecticides, agricultural seeds and the testing and marking of Babcock glassware, pursuant to sections two hundred and twenty-four, one hundred and sixty-four and one hundred and forty-three of chapter nine of the laws of nineteen hundred and nine, section thirty-four and section fifteen, chapter two hundred and ninety-seven of the laws of nineteen hundred and twelve	17,470
Grand total for maintenance	$143,740

The increase for maintenance requested for 1916-17 is $3,540. Of this $2,700 is for increases of salaries of associates and assistants, these increases varying from $100 to $250 per year. Provision is also made for another stenographer, such additional help being needed.

It is to be noted that the appropriations for the maintenance of the Station are classified in several divisions as, for instance, two items for expenses and separate items for investigations in grape culture and investigations of orchard, truck and garden crops and methods of milk sanitation. This is an unnecessary and to some extent burdensome division which came about through the way in which additional funds were provided. The grape growers of Chautauqua County wished aid and secured a separate appropriation and later the income of the Station was increased by an item for field investigations and studies of milk sanitation. The work of the Station is practically a unit; that is, its scientific staff participates in all of this work outside of inspection, and the law establishing the Station and the language now used in defining necessary expenses of investigations are comprehensive and exclude nothing of an agricultural character. I therefore suggest that the Station budget be more or less consolidated. It would be well if the individualizing of salaries should not be insisted upon. Outside of the salary budget, whether or not this is individualized, I would recommend the following divisions of the budget:

General salaries of members of scientific and clerical staff (individualized if desired)	$84,720
Labor, including janitors, poultryman, engineer, herdsman, foreman of orchards, florist and gardener, general mechanic, watchman, teamsters, farm and other common labor (this list to be individualized with the exception of teamsters and common labor)	24,320
The necessary expenses of investigation and the general maintenance of the institution, excluding salaries and labor, but including chemicals, scientific apparatus, farm machinery, fertilizers, cattle foods, maintenance of working animals, traveling expenses and other expenses, including general repairs to Station buildings, necessary for conducting investigations at the institution and throughout the State in soils, plant nutrition, horticulture, diseases of plants, injurious insects, bacteriology, animal nutrition, dairy practice and poultry keeping	34,700

Such a division of the budget would simplify the bookkeeping both at the institution and in the Comptroller's office and would render the administration of the funds much more simple and convenient.

I must renew my earnest recommendation that the salary list either be appropriated in a lump sum or else a contingent fund be provided for such changes in salary as seem necessary to the maintenance of the efficiency of the institution. A more extended discussion of the Station's budget appears later.

NEW EQUIPMENT.

I can not do better than to quote the language used in my report for 1914 relative to the need of new buildings. The time has come when the State must face the question as to whether it will maintain and develop the Experiment Station in accordance with the increased demands made upon it for public service, or witness a failure to meet the demands on it and a decline in efficiency.

"The Experiment Station was established in 1882, and since that time it has been growing slowly but continuously. This growth has not been forced but has been the result of demands made by agricultural people for the solution of important problems. During the eighteen years in which I have been connected with the institution, the scientific and clerical staff has increased from fourteen persons to approximately forty. The building equipment has also increased, but not at all in proportion to the demands made upon the Station. For several years an effort has been made to secure a building which would serve at the same time to accommodate the administrative offices, give space for the visualizing of results which we have reached and provide for an auditorium. During this time other needs have become very apparent and by direction of your Board what may seem to many a liberal sum of money is now being asked for additional equipment. The coming Legislature is to be asked for appropriations for three buildings—an administration, demonstration and library building, new forcing houses and a building providing cold storage facilities.

" The reasons why we ask for the larger building have been stated many times, but are here again summarized:

" The Station has no audience room where agricultural societies and other bodies of farmers may meet for the discussion of our work. During the summer season, large bodies of farmers come to the Station and in case of rain (which frequently occurs) it is not possible for an audience to assemble. More visitations would be made if we had an audience room. Agricultural societies would meet with us if an audience room was available. No other agricultural institution, of which I know, is placed in so awkward a situation.

" At least three existing departments of the Station need more space and the new department for the investigation of soils must be provided with quarters much larger than it now possesses. The new building would relieve space in two other buildings in order to give needed rooms for the departments mentioned.

" The Station is seriously in need of a generous amount of space, not now provided, for setting up objective demonstrations of its work in dairying, plant diseases, injurious insects, horticulture, fertilizers and feeding stuffs in order that the visitors, who come to us by hundreds, may gain an intelligent idea of what the Station has done. Such demonstrations are also needed if agricultural bodies are to meet with us.

" The Station has now come to possess a valuable library of several thousand volumes, and space in fireproof quarters should be provided for this library. It is now located in the old mansion house bought with the Station farm.

"The old mansion house, now occupied by the administrative offices and library, is needed as a place where the members of the staff and other employees can get meals, and where living rooms can be furnished to those persons who should be on the Station grounds. The Station is a mile and a half from the city where board can be obtained and it is time-consuming and wasteful for members of the Station staff to travel so far in order to get a midday meal. It is important that such accommodations exist as the mansion house would furnish if the administrative offices and library could be moved into another building.

"In the thirty years' existence of the Station, there has been appropriated to it for buildings in all only $155,450. Twenty-seven buildings now exist on the Station property, and it is fair to claim that no other State institution has a better record for economy of expenditure in the way of building equipment.

"The time has come when in order to carry on its work with the desired efficiency new and greatly enlarged plant houses should be provided. The present plant houses of the Station were erected about twenty-five years ago. They have exceeded the usual life of such structures, and are now neither adequate nor efficient. There is a large amount of work in agricultural investigation which should be carried on in such houses, if carried on at all, including plant breeding, plant nutrition and studies of plant diseases and injurious insects, to all of which lines the Station is obliged to give much attention.

"The small cold-storage house, established chiefly for the storing of fruits, was erected at the Station something more than twenty years ago. The preservation of fruits, of which the Station has several thousand varieties, requires cold storage facilities in order that such materials may be used for study and exhibition purposes. The present cold-storage plant is inadequate in size and construction and if retained will need enlargement and extensive repairs. A new building should be erected."

There has developed within the past year an opportunity to purchase what is now known as Smith Park, a tract of land of 23 acres, lying adjacent to the Experiment Station property. It is probable that unless this land is acquired by the Station it will be divided into building lots and ultimately become a part of the thickly settled portion of the city. From every point of view this would be very undesirable so far as the Station interests are concerned. It is now difficult to protect the Station grounds, on which are planted thousands of varieties of fruit, from marauders. If the adjacent population is largely increased, the Station's experimental work is liable to suffer from the invasions of persons who have no respect either for the work we are doing or the rights of property. Much trouble of this kind is experienced now.

More than this, it is important that the Station should have an area on which both to develop an arboretum and to collect the various species of wild fruits from which our cultivated fruits have been developed. This would be a great aid to our studies of plant breeding.

The sums suggested for these various additions of equipment and land are as follows:

Administration, Library and Demonstration Building	$100,000
New Forcing Houses	25,000
New Cold-Storage Building	10,000
For the purchase of Smith Park	33,000

This totals a much less sum of money than has been provided for single buildings for institutions which, however important, have a less wide relation and application to the agriculture of the State than does the Experiment Station.

PUBLICATIONS.

During the year 1915 the following publications have been issued by the Station: 20 Complete Bulletins, 8 Technical Bulletins and 14 Circulars. Of the so-called Complete Bulletins 12 have been issued in a popular form more adapted to use. The following is a statement of the number of bulletins of each class issued from the various departments of the Station:

Publication	Administration	Agronomy.	Bacteriology.	Botany.	Chemistry.	Entomology.	Horticulture.	Inspection.
Bulletins	1	1	3	4	......	2	6	3
Technical bulletins	......	1	......	1	4	1	1	......
Circulars	1	2	......	.....	......	2	9	......

The Station bulletins are distributed in practically every county of the State. There is a gradual, though not marked, increase from year to year in the number of persons receiving these publications. Many requests are received for distribution of our bulletins in bulk; that is, by sending 100 or 500 or some other number to a party making the request, these to be distributed by him. It is not the policy of the Station to comply with such requests. Distribution of bulletins in this form is a waste of material and it is out of the question for the institution to determine the edition that should be published if such requests were to be met. It is to be emphatically stated that personal requests for single numbers or carefully selected lists of our bulletins will always be honored unless the publications asked for are out of print. The technical bulletins and circulars are not intended for general distribution, the latter being prepared as an aid to answering the numerous inquiries received at the Station. The names now on our mailing lists are approximately as follows:

POPULAR BULLETINS.

Residents of New York	40,000
Residents of other States	2,309
Newspapers	750
Experiment stations and their staffs	2,210
Miscellaneous	100
Total	45,369

COMPLETE BULLETINS.

Experiment stations and their staffs	2,210
Libraries, scientists, etc	330
Foreign list	344
Individuals	3,652
Miscellaneous	100
Total	6,636

Part 2nd of the Report of the Station for 1914 consisted of a publication known as "The Cherries of New York." This is the fourth fruit monograph which we have issued. As was the case with the other fruit books, there is a widespread demand for this one. Of the nine thousand copies printed, two thousand only are assigned to this institution and every effort is made to place these in libraries, schools and with actual growers of fruit in such a way as to accomplish the most good. It is to be feared that many of the copies not distributed by the Station are not wisely used. It is a fact that a copy of "The Grapes of New York" was found in an ash barrel in the City of New York and evidence of a similar character exists with reference to the distribution of other of the fruit monographs.

The fifth number in the fruit monographs will be known as "The Peaches of New York," and it is anticipated that this, when issued, probably in 1918, will be the most satisfactory number in the series.

MAINTENANCE OF AGRICULTURAL RESEARCH THROUGH THE USE OF PUBLIC FUNDS.

Our Federal and State Governments are at present applying large sums of money to the maintenance of an extensive system of agricultural education and research. These funds have been used largely to develop and support the agricultural colleges and experiment stations. It should be said that in general the appropriations of money to these institutions have been generous. This is made evident on the Experiment Station side by the following figures showing the annual appropriations to the experiment stations of several States for the year 1914:

Ohio	$481,000
Minnesota	396,000
Indiana	315,000
Illinois	298,000
Kentucky	285,000
California	205,000
Iowa	162,000
Nebraska	149,000
New York, 1915–'16	143,000

There is a growing tendency in the country at large, and particularly in New York, to scrutinize closely and in great detail the use of public money, a tendency much to be commended. After the people have set aside certain sums to be expended for definite purposes, it is their right to know whether these funds are honestly and efficiently applied to the purposes for which it was intended they should be used.

As a means of securing fuller control over the expenditure of public money, there is being more or less adopted in appropriation bills what is known as the budget system, which is a departure from the older method of assigning funds in lump sums. The budget system means a more or less detailed segregation into items of the total appropriation of a given department or institution, each item being assigned very definitely to a specified purpose. However much there may be to commend this general method of appropriating public money, there is in it a distinct menace to the welfare and efficient administration of any scientific institution to which a budget system is applied. This is especially true of an agricultural experiment station because of the peculiar relations it sustains and the complexity of its activities.

In the first place, scientific research, whether agricultural or otherwise, requires the services of men of special aptitude and preparation who must be found or, more often, must be developed into efficient relations to the problems to be solved, and to the institutions to which they become attached. The salaries of scientific workers are not standardized and they ought never to be. Each man has his own value to an institution, and to the public, and somewhere this value is sure to be recognized. For this reason each State or institution should exercise large freedom in the use of funds to secure and retain men of recognized scientific ability in the fields in which their services are needed.

In the second place, there is an open competition among the experiment stations of the various States for men with which to build up their staffs. These institutions enter a competition that has become nationalized. No important State is independent of the ambitions of other States in this respect. For this reason the segregation through legislation of a salary budget on an individual basis is a menace to the welfare and efficiency of an institution that must compete with many other institutions in securing and holding scientific investigators. It so happens that at the present time the competition among experiment stations for high-grade men is especially keen, for the demand is greater than the supply and this condition seems likely to continue. To tie the hands of the New York Station by way of fixed salaries places it at a serious disadvantage.

A close segregation of the funds applied to the maintenance and operation of an experiment station is also bound to be obstructive to its efficient and economical management. The expenses of an institution conducting various lines of scientific investigation cannot be stabilized very much in detail. This should not be attempted. Consideration must be given to certain facts; namely, that in agricultural investigation the work is complex, is variable from year to year and in some of its phases is widely distributed. The expense of field experiments on a given basis varies greatly according to the season. Variations in the productiveness of different seasons modify the extent to which certain supplies must be purchased. It is utterly impossible to prophesy nine months or a year ahead just what directions the work of an experiment station will take after a lapse of such periods of time. Agricultural investigation does not run in grooves, neither can the distribution of its expenses.

The argument that all State institutions with varying functions should be administered under a financial system uniform in details is no more convincing than to assert that jaundice and typhoid fever should have the same medical treatment. In view of these facts, "It is a serious case to deprive the responsible officer of an institution of the right to exercise his discretion." The State will make a blunder if it undertakes to administer a prison and an experiment station on the same basis. It will also be greatly unfortunate if such an institution as an experiment station is placed under such close and technical fiscal control as to make its administration difficult and burdensome. In a recent address Dr. L. H. Bailey, a man of large experience in agricultural education and research, declares "We are face to face with a struggle to keep educational institutions free . . . from the deadly domination of fiscal offices." "The institutions (of a State) must be allowed to become what they are intended to be." They must be treated in accordance with what they are.

I offer the following suggestions:

(1) If a salary budget is itemized on an individual basis a contingent salary fund should be provided in order that the administrative officer may retain or secure men as is demanded by the best interests of the institution in his charge.

(2) If the funds provided for the maintenance and operation of an institution for agricultural investigation are to be segregated, these should be only on broad lines and a reasonable percentage of the total appropriation should be provided as a contingent fund in order to give elasticity to the work of the institution, or else the

administrative officer should be allowed to transfer from one item of the budget to another upon due notice to the fiscal department of the State.

THE STATION AS A BUREAU OF INFORMATION.

The Station is a source of information to the agricultural public in three ways: first and most importantly through its literature that is supplied to teachers, farm bureau agents and the general public; second, through addresses given at important agricultural meetings and to some extent at Farmers' Institutes; and third, through correspondence with farmers.

As to the first means it should be distinctly understood that the Station desires to make the largest possible use of the farm bureaus as a means of distributing the knowledge which is acquired through its investigations. Occasionally the Station has been asked for large quantities of literature to be placed in the hands of a Farm bureau agent for distribution. It is not found feasible to do this because there seems to be no way of arranging for the size of the edition of our several publications if bulk distribution of that kind is to be carried on. Moreover, such distribution would be the means of placing bulletins in the hands of persons already receiving these publications through our mailing list. In general the handing out of publications in a promiscuous way has not been found to be an efficient means of using literature. It is felt, too, that the extension effort should bear its own expenses and it is not considered fair to charge the Experiment Station with the expense of thousands of bulletins to be distributed through other agencies.

The second means of extending a knowledge of what we do is through addresses given before the various agricultural bodies of the State. To illustrate, every year several members of the staff appear before the New York State Fruit Growers' Association and the Western Horticultural Society and give popular résumés of the new facts which we have brought out during the year. In view of the high character and intelligence of the members of these and other societies, we feel that such effort is very fruitful.

As to correspondence, it must be confessed that it is at times burdensome to men who are endeavoring to give their whole time and attention to investigational and experimental work. During the past three years the letters which have been sent out from this institution have varied from approximately 13,500 to 15,000 per annum. While some of these are a part of the administrative business of the Station a very large proportion of them are written in replies to inquiries from individual farmers. This correspondence is lightened very much by the preparation of leaflets and brief circulars that are used in many instances to answer inquiries more fully than would be possible through correspondence.

A PROPOSED AFFILIATION BETWEEN THE NEW YORK STATE COLLEGE OF AGRICULTURE AND THE NEW YORK AGRICULTURAL EXPERIMENT STATION.

The interests and work of the State College of Agriculture, at Ithaca, and the State Experiment Station, at Geneva, have much in common. While the Experiment Station has a single function, that of investigation, the College of Agriculture combines with its teaching function scientific inquiry into agricultural problems. There has existed for many years a harmonious relation between these institutions, and it is believed that there has been by them no unnecessary duplication of effort along investigational lines. Notwithstanding all this, members of the staff of both institutions have come to feel that it will be well to establish a closer and more definite relation between the two.

There are two reasons for this point of view: (1) Both institutions are working in the interests of agricultural practice through investigation, and it is believed that greater momentum and efficiency may be secured through cooperative effort. (2) There are along certain lines unusual opportunities for graduate work at the Station which should be open to members of the College staff and the graduate students resident at the College, and, on the other hand, members of the Experiment Station staff often desire to pursue graduate work at the College either in the study of some problem or with a view to securing an advanced degree. It is believed that the plan of affiliation herein set forth will make it possible for members of the Station staff to receive credit toward an advanced degree for non-resident work done at the Station.

The following plan of affiliation has been proposed, and it is presented here for discussion before your Board and for the consideration of all who are interested in the welfare of the institutions that it is proposed to affiliate:

1. The autonomy of each institution shall be maintained through a mutual agreement between the New York Agricultural Experiment Station and the New York State College of Agriculture on a program of work.

2. Greater unity of purpose in research work will be secured by relieving the New York Agricultural Experiment Station of extension activities so far as practicable.

3. A selected list of the scientific staff of the New York Agricultural Experiment Station shall be members of the faculty of the New York State College of Agriculture as agreed upon by the Director of the New York Agricultural Experiment Station and the Dean of the New York State College of Agriculture.

4. A selected list of the faculty of the New York State College of Agriculture shall be members of the scientific staff of the New York Agricultural Experiment Station as agreed upon by the Dean of the New York State College of Agriculture and the Director of the New York Agricultural Experiment Station.

5. There may be mutual agreement between the New York Agricultural Experiment Station and the New York State College of Agriculture as to budgets and funds for joint research projects in both institutions.

6. There shall be joint agreement as to form of statement of affiliation to go on all publications of joint research.

7. There shall be joint agreement as to the proper method of publication of joint research.

INSPECTION WORK.

The number of samples of fertilizers and feeding stuffs forwarded to the Station by the Commissioner of Agriculture for analysis in compliance with the requirements of the law was about the same for 1915 as for 1914. The same is true of the samples of agricultural seeds. There has been quite a material increase in the number of pieces of Babcock-test glassware examined. Following is a statement of the work performed along these various lines during the year 1915:

Fertilizers	868	samples
Feeding stuffs	858	"
Agricultural seeds (official)	323	"
Agricultural seeds (from private parties)	777	"

Babcock-test glassware:

Milk bottles	23,097
Cream bottles	4,396
Pipettes and acid measures	4,696
Total	32,189

Relative to the seeds, it is worthy of note that the percentage of violations of the law, that is, samples containing over 3 per ct. of foreign seed without being so labeled when exposed to sale, has been steadily falling off during the past four years. The violations for these years were as follows:

1912	20.8 per ct.
1913	17.5 " "
1914	10.9 " "
1915	4.6 " "

EXPERIMENTAL WORK OUTSIDE OF THE STATION LABORATORIES AND GROUNDS.

The Station is continuing its special work touching the grape industry both in Chautauqua and Steuben Counties. The experimental hop and tobacco fields are also being maintained. In connection with each division of work may be seen a list of the experiments now being conducted in various parts of the State. This shows that 21 problems are being considered through the cooperation of 68 farmers on as many farms in various parts of the State. The officers of the Station desire to express their high appreciation of the opportunities thus given for experimental work and of the hearty and efficient cooperation of those on whose farms we are conducting these experiments.

INVESTIGATION.

AGRONOMY DIVISION.

The significance of the term "agronomy" may be expressed in the phrase "the production of crops." Considered broadly, the production of crops includes practically every activity of every division of the Station staff, chemical, biological and technical, because every division of the Station staff relates itself in one way or another to crop production. A narrower definition of the function of the Agronomy Division would be that it relates itself to the maintenance of soil fertility through soil improvement and modification whether by means of culture or soil amendments in the shape of various forms of fertilizers. It very properly also relates itself to the improvement of the type of crops grown and the adjustment of those crops to localities. An Agronomist, however, must be looked at much as the obsolete Professor of Agriculture. He cannot make his field as comprehensive as is the whole scope of crop production, but the study of biological and crop-breeding problems must necessarily be assigned to separate and special divisions of effort.

The efforts of the Agronomy Department of this institution have been so far along three general lines: (1) Special laboratory investigations concerning methods of analysis and composition of certain materials. (2) Investigations under close control of certain production problems, such as can be carried out by means of lysimeters, forcing house experiments and pot experiments in the open air. (3) Field experiments relative to soil amendment and the use of fertilizers.

Much work has been accomplished along several lines, the data from which are not sufficiently comprehensive or extended for publication. Two bulletins have been published during 1914, both of which relate to the sources, composition and use of limestone as a means of soil amendment.

Bulletin 400 takes up the question of ground limestone as related to its practical use in this State. Chemical analyses are given showing the composition of representative samples of ground limestone from each of twenty-nine quarries in this State producing that material during 1914; also samples from six quarries in adjoining states shipping into New York. The statements of analyses show percentages of calcium carbonate, magnesium carbonate, total carbonates and calcium carbonate equivalent. Figures for the latter represent the total carbonate carbon calculated to calcium carbonate, and this gives a basis for comparison of the acid-neutralizing value of different stones. The figures for calcium and magnesium carbonates represent the actual amounts of those compounds contained in the stone, and are not obtained by calculating the total calcium and magnesium to carbonates as is the usual method.

The opinion is expressed in this bulletin that at least three-fourths of the farm land in New York is in need of liming. It is clearly not possible at present to draw any sharp limits as to the percentage of land which does or does not need liming, but it is very evident that large areas are improved for crop production through the use of some form of lime.

It is held in this bulletin that generally ground limestone is to be preferred to the burned lime, doubtless because the ground limestone is less expensive in most localities, and is a more comfortable material to apply to the land. It should be conceded, however, that there may be conditions under which the burned lime would be the more desirable means of soil amendment. As to the relative effectiveness of the two forms, no data have been published from investigations or experiments conducted in New York which justify a final conclusion.

The question of the relative effectiveness of very finely ground limestone as compared with that all of which would pass through a 10-mesh sieve has been much discussed, and the issue involved has not been clearly set forth. Because it is held that it is not wise to require limestone to be ground to a greater fineness than will permit it to pass wholly through a 10-mesh sieve, it is not inferred that the very fine material is not more immediately efficient than the coarser material. Indeed, it would not be rational to make this claim. It is held, however, in the bulletin in question, that where a large quantity of limestone is applied there is a sufficient percentage of very fine material for immediate effect if the whole material will pass through a 10-mesh sieve, the coarser material becoming available in the course of time. It is desirable that the confusion in the question at issue should no longer exist.

Technical Bulletin No. 47 presents a study of the limestone deposits of the State of New York with reference to their agricultural value. This study, which is based upon previous geological reports and upon field work carried on by the Station during two seasons, is chiefly valuable to those who wish to develop lime quarries for agricultural use rather than to the farmer, although it is desirable that the industry of grinding limestone shall be developed to such an extent as to make this material generally available throughout the State at reasonable prices. Forty-nine distinct limestone formations are briefly described and their chemical composition is given in numerous tables of analyses. A map accompanying the bulletin shows the extent of all the important limestone outcrops within the State. Two large charts representing stratigraphic columns, one for the eastern and one for the western half of the State, show the geologic relation of these limestones to other rock formations, and also represent to scale the thickness of the limestones in different sections of the State. Eleven photographs show typical sections and characteristic features of some of the more important limestones. Under the heading "Types of Limestone" are discussed high calcium, magnesium, dolomitic and hydraulic limestones, and also marble. The subject of origin of limestone is referred to very briefly.

A popular treatise known as Circular 39 has been issued, which deals with the production of alfalfa on land not naturally adapted to that crop. This circular is intended as a means of answering inquiries rather than for general distribution as is the case with our bulletins. This circular points out that the greatest problem connected with the growing of alfalfa in New York State is its successful production on land to which it is not naturally adapted, since such lands comprise perhaps three-fourths of the farm land of the State. The difficulties to be overcome in preparing these lands for alfalfa vary greatly in number and extent. A liberal application of limestone is of course one of the chief essentials, and the amount needed varies with different soils all the way from one to ten tons per acre. The circular also discusses the questions of seed-bed, fertilizers, inoculation, time of seeding, cutting and curing alfalfa. Brief reference is made to some experiments being conducted by this Station in the growing of this crop on some of the poorer lands of the State.

There follows a list of the localities and other data concerning field work performed by the Station outside of the Station farms. So far as this work relates to alfalfa culture it is supplemental to a large amount of work performed by the Station several years ago under the direction of the Bacteriological Division. It should be clearly held in mind that this outside field work relating to alfalfa culture borders closely on demonstration work, which properly falls in what is known as extension teaching, and it is hoped that as the effort at extension teaching develops in this State it will be necessary for the Station to devote less time and energy to this kind of effort so that it will be possible to enter more extensively into the severer investigations, only through which will the fundamentals of agricultural practice be worked out. The experiments relative to the maintenance of the fertility of orchards are conducted in cooperation with the Horticultural Division. Interest in these experiments is intensified by the fact that certain past utterances of the Station concerning orchard fertilization have been much criticised. It is desired to secure extended data on the profitableness of using commercial fertilizers in orchards.

Alfalfa culture on southern New York hill lands:	L. Gallager (½ acre), Oxford.
	C. G. Baker (1 acre), Chenango Forks.
	H. G. Skinner, Jr. (1 acre), Prattsburg.
	A. S. Matherny (½ acre), Binghamton.
	L. W. Rorapaugh (½ acre), Cortland.
	H. W. Cornell (½ acre), Elmira.
	F. A. Wigsten (½ acre), Elmira.
	F. D. Swezey (½ acre), Sherman.
	J. S. Carnes (½ acre), Great Valley.
	F. C. Gibbs (½ acre), Fillmore.
	H. B. Adams (½ acre), Wellsville.
	Gen. Lyon (½ acre), Binghamton.
	L. E. Hooker (½ acre), Portville.
	F. D. Rice (½ acre), Homer.
	W. P. Mead & Son (4 acres), Jamestown.
	B. L. Winters (4 acres), Smithboro.
	A. R. Chappel (2 acres), Sidney.
	W. N. Tarbell (1 acre), East Freetown.
Apple orchards: Fertilizer, cultivation and cover-crop tests:	Great Bear Springs Co. (8 acres), Fulton.
	R. B. Densmore (8 acres), Albion.
Cherry orchard:	P. F. O'Neil (3 acres), Geneva.
Peach orchard:	T. H. King (3½ acres), Trumansburg.
Pear orchard:	L. L. Morrell (4 acres), Kinderhook.
	Lawrence Howard (3 acres), Kinderhook.
Vineyards: Fertilizer and deep-plowing tests:	S. E. Stone, Jr. (4 acres), Fredonia.
	D. W. Blood (2 acres), Dunkirk.
Tobacco-culture experiments:	F. A. Tuerk (12 acres), Baldwinsville.
	B . I. Crego, Baldwinsville.
Hop-culture experiments:	P. R. Bannett (6 acres), Milford.

BACTERIOLOGICAL DIVISION.

This division has given attention during the past year chiefly to questions directly related to stable and milk sanitation and to a study of soil organisms. A discussion of the data already secured will soon be issued.

Investigations of barn and milk sanitation have centered around four general problems: (1) The influence of the various factors included in barn conditions upon the bacteriological quality of milk. (2) The relation of existing score cards that have heretofore been used as a basis of grading milk to the actual bacteriological quality of the milk. (3) The application of a new microscopical method of grading milk. (4) The prevention of the spread of tuberculosis through the distribution of dairy wastes from butter and cheese factories.

(1). *The influence of the various factors included in barn conditions upon the bacteriological quality of milk.*—The earlier production of certified milk or of milk of a high sanitary quality by the methods then in use was very expensive, and only the well-to-do could afford to use such milk. The question was very early raised by members of the Station staff whether entirely healthful milk could not be produced at a much less cost. In order to determine whether this was so or not, it became necessary to make an extended study of the influence of the various factors reacting upon the milk before leaving the stable as well as the factors influencing the sanitary quality after the milk was on its way to the consumer. Certain of the results that have been secured have been published in previous bulletins. Additional data are given in Bulletin No. 409. This bulletin deals almost entirely with the influence of the dust in the barn air, which has been thought to have a large influence in causing the initial contamination of milk.

The bacterial study of the contents of stable air proved to have many difficulties and a large amount of time was consumed in an extended study of the various technical methods which have been suggested for determining the number of bacteria in the air. The results of this technical study have been issued in the form of a technical bulletin which was previously published in Vol. 4 of the *Journal of Agricultural Research*. The conclusions drawn from the completed work may be briefly stated by saying that the number of bacteria in milk derived from the dust of the air of ordinary stables is too small to be measured even by the most refined methods of counting bacteria in milk. By using an indirect method of measurement, the numbers of bacteria thus added to milk were found to vary between 1 and 73 per cubic centimeter in the Station stable. A study of three dairies in the vicinity showed that the conditions present in these stables were similar to those in the Station stable. Even milking under conditions so dusty that they would not be tolerated in any stable did not increase the number of bacteria more than several hundred per cubic centimeter.

The Station does not desire to teach that it is not undesirable to have a dusty barn air where cows are being milked, but simply wishes to point out the facts. As has been previously stated in other publications, if the dairy farmer is to produce sanitary milk in the most economical way it is necessary for him to know what factors are most influential in producing an unsanitary condition of the milk. He must know where the greatest amount of care is needed in order to avoid bad results.

(2). *The relation of existing score cards that have heretofore been used as a basis of grading milk to the actual bacteriological quality of the milk.*—An extended investigation has been carried on along this line, the results of which are given in Bulletin No. 398. The method followed was to score a number of dairy farms in accordance with three of the commonly used dairy score cards and at the same time make a study of the bacterial content of the milk. Thirty-four dairy farms were studied in this way, using the Cornell score card, the New York City Board of Health score card and the Official Dairy Instructors' score card. In general, the New York City card was found to be the most severe and the Cornell card the most lenient. The data secured for the comparison between the dairy scores were especially valuable, for no previous work of this kind had been done with the bacterial count in the district studied while much emphasis had been placed upon the securing of high scores. The results of the comparison showed no relationship whatever between the dairy scores and the bacterial count. In fact the lowest count milk was brought in from a farm scoring so low that its product would have been refused admission to the New York city market. On the other hand, the dairy which received the highest score on all of the cards, a dairy which in appearance and equipment would be placed among the best dairies in the State, was bringing in milk which invariably had a bacterial count in the millions. The conclusion drawn was not that dairy score cards are a failure, but that the present cards are not satisfactory measures of the quality of milk.

In displaying the facts as the Station found them, the intention is not to encourage dirty and careless stable conditions, but to point out the necessity of scoring the milk as it actually is rather than scoring the place from which the milk comes. Filthy barn conditions are very undesirable, because in the midst of filth it is not as easy to control those factors which have the most immediate relation to the condition in which the milk leaves the stable. It is clear, however, that when certain factors, particularly the cleanliness of the animal, of the man and especially of the milk utensils, are carefully looked after, certain other conditions have comparatively small influence upon the bacterial content of the milk.

(3). *The application of a new microscopical method of grading milk.*—In the report of the Director for the year 1914, attention was called to a new method for counting the bacteria of milk, which appeared to have great promise as a rapid and efficient method of grading milk on the basis of the bacteria present. The method seems to be justifying itself, and it now appears that it is likely to be adopted as a means of grading the milk entering our cities, both by city officials and by private milk companies.

(4). *The prevention of the spread of tuberculosis through the distribution of dairy wastes from butter and cheese factories.*—Dairy wastes have been proven, in Wisconsin, a prominent source of the spread of tuberculosis among bovines and swine. If a single patron of a butter factory has in his herd badly infected cows, such as are known as spreaders, the skim milk is likely to contain the germs of tuberculosis and through a general distribution of such milk to the patrons of the factory to be fed to calves and swine many animals, distributed over a wide area, may become infected.

The remedy suggested for such a spread of disease is the pasteurization of the dairy wastes. It is probable that the more important source of infection is the skim milk as it does not seem likely that the whey, after the milk has passed through the fermentation process and the curd has been removed, is as liable to contain the disease germs as is the skim milk where no fermentation has occurred and where only the cream has been removed. It has been proposed that a law be enacted in New York requiring all butter and cheese factories to pasteurize the skim milk and whey. As preliminary to the discussion of such a law a commission appointed for the purpose of studying the whole question of bovine tuberculosis decided that it was wise to make something of a study of the efficiency of the pasteurization methods now in use in various factories in the State. This Commission asked for the cooperation of the Station in making such a study, a cooperation into which the Station was very glad to enter. The plan adopted was the securing of samples of the pasteurized dairy wastes from a number of milk and cheese factories that had entered upon the pasteurization of their wastes, these samples to be studied with reference to the efficiency of the methods employed. The information thus secured has been published in Bulletin 412. The most important new observations made in the course of this work were concerning the distribution and activities of the long rod, lactic-acid bacteria commonly known under the name of *Bacillus bulgaricus*. Recent investigations had shown this to be a widely distributed organism present in all milk and one which was intimately concerned in the ripening of cheddar and swiss cheese. This investigation of dairy by-products has shown it to be the common organism concerned in the souring of both pasteurized and unpasteurized whey. The fermentation in the heated whey was due primarily to this organism while that in unheated whey was due not only to *B. bulgaricus* but also to yeasts and a variety of other organisms. Four of the seven cheddar cheese factories visited were found to be securing an efficient pasteurization of the whey returned to the farmers. The others were securing inefficient results because of the low temperatures used or because separator slops and washings were added to the whey after it was too cool to kill the bacteria added. One of the two skimming stations visited was securing efficient results but was using an unnecessarily expensive method of pasteurizing the skim milk.

Cooperative studies.— Considerable cooperative work has been entered into for the purpose of adjusting certain Station results, particularly the new method of counting bacteria, to commercial relations and use. To this end the Station has joined with other laboratories in making tests of the new method of counting bacteria as a means of grading milk. The cooperating laboratories are mentioned below.

There has also been cooperation in the study of score cards with reference to the adoption of a revised form more nearly in accord with existing knowledge.

The Station is also joining with the Illinois Agricultural Experiment Station in studying the sources of the contamination of milk. Below may be seen a list of all these cooperative studies.

Methods of controlling the sanitary quality of market milk, White Springs Farm Dairy Co		Geneva.
Methods of controlling the sanitary quality of market milk, Geneva Milk Co		Geneva.
Pasteurization of whey	H. S. Sweetland	So. Dayton.
	Geo. E. Hogue	Arcade.
	Gibby & Evans	Cattaraugus.
	F. X. Baumert & Co	Antwerp.
Pasteurization of skim milk	Dana H. Wells	Fayetteville.
	Sheffield Farms, Slawson, Decker Co	Hobart.
Methods of counting bacteria in milk	Work done under the supervision of Prof. H. W. Conn, Middletown, Conn., with the New York City Board of Health Laboratory, Borden's Laboratory, Lederle Laboratory and North's Laboratory	N. Y. City.
Methods of counting bacteria in milk	Cornell Agricultural Experiment Station, Department of Dairy Bacteriology	Ithaca.
Sources of contamination of milk on the farm	Illinois Agricultural Experiment Station	Urbana, Ill.

BOTANICAL DIVISION.

This division of the Station staff confines its efforts almost wholly to the study of plant diseases and the means of preventing their ravages. It is too much to claim that the work of the Station along this line adequately meets the situation. Fungus troubles are many in kind and an investigation of their nature and life history together with a study of the means of minimizing their destructive influence often requires a long-continued period of the closest study. The Station resources do not permit of the carrying on of very many studies of this nature at the same time.

The publications of the Botanical Division for the year 1915 relate to the following:

The powdery mildew of hops.

The spindling-sprout disease of potatoes.

A comparison of the lime-sulphur solution with bordeaux mixture as a spray for potatoes.

A test of the comparison of very thorough spraying with ordinary spraying or with no spraying at all.

An investigation of the stem rot and leaf spot of clematis.

The powdery mildew of hops.— As previously stated, the work on the powdery mildew of hops as a subject of investigation has been discontinued. It is believed that there has been pointed out to hop growers a reasonably efficient method of controlling this fungous pest. The following is a brief, general statement of the results reached as given in Bulletin No. 395:

It was found that fresh mildew spots appear about ten days after each rain. This indicates that infection occurs during periods of wet weather and points to the advisability of applying sulphur as soon as possible after such periods.

In comparative tests of different kinds of sulphur with respect to their efficiency in the control of mildew it was found that with unfavorable weather conditions, such as prevailed in 1914, flour sulphur was considerably more efficient than flowers of sulphur; while in the drier seasons of 1912 and 1913 both kinds gave nearly perfect control even in severe attacks of mildew. Extremely fine flour sulphur is difficult to apply. Coarse flour sulphur should be avoided. Flour sulphur of a medium degree of fineness is the most satisfactory. Pure sulphur gives better results than mixtures of sulphur and lime.

By the use of the sulphur dust treatment mildew may be controlled at an expense of about eight dollars per acre.

The spindling-sprout disease of potatoes.— Potato growers have probably noticed for many years that there occasionally appears a hill of potatoes exhibiting very small, weak plants with slender stems. This condition was particularly noticeable on Long Island in the spring of 1914 where the potato fields planted with home-grown seed were quite generally in poor condition, showing a very uneven stand of plants. Investigation has shown that this condition was due to using for seed, tubers which produced slender thread-like sprouts. Why such tubers exist is not thoroughly understood, but there are reasons for believing that in the case mentioned the cause was the heat and drought in the season of 1913. Tubers from which such weak plants develop are unfit for seed and about the only suggestion that can be made at present is that Long Island potato growers when they use home-grown seed should make a sprouting test of their seed potatoes.

A comparison of the lime-sulphur solution with the bordeaux mixture as a spray for potatoes.— It does not follow that, because a given fungicide is safe and effective with one plant, it can be used with equally good results on all other plants. The lime-sulphur solution has proved a valuable preventive of fungus troubles with the apple. Is it equally effective on potato plants? Some time ago the Station entered upon a comparison of this solution with the bordeaux mixture which had been used for potatoes for so long a time. These experiments were continued in 1913 and 1914, and the results published in Bulletin 397. The experiments for these two years give essentially the same results as experiments previously reported. They show that lime-sulphur is harmful rather than beneficial to potatoes. On the one hand, the bordeaux mixture checked tip burn, caused the foliage to take on a darker green color, prolonged the growth of the plants and increased the yield of tubers. On the other hand, the lime-sulphur solution aggravated the tip-burn, dwarfed the plants, shortened the period of growth and reduced the yield of tubers. It should be stated that the efficiency of the lime-sulphur solution as a preventive of late blight has so far not been tested and further experiments will be made in this direction.

A test of the comparison of very thorough spraying with ordinary spraying or with no spraying at all.—There were carried on at a point not greatly distant from the Station in both 1913 and 1914 tests of the value to the potato grower of thorough spraying as against a neglect of the potato grower in this particular. These tests in 1914 were conducted in 82 fields where a small area was very thoroughly sprayed by hand every two weeks. At the time of digging, this area was compared in yield with an adjacent area which had either ordinary spraying or no spraying at all. In 56 of these fields no spraying was done by the owner, and the comparison here was between the thorough spraying and no spraying. In the other 26 fields more or less spraying was done by the owner, and here the comparison was made between the very thorough spraying and the kind of spraying done by the owner. In the 56 fields where unsprayed areas were left the spraying done by the Station increased the average yield by 15.8 bushels of potatoes per acre, or 8 per ct., and in the 26 fields where the spraying was of the ordinary kind the increase due to the more thorough work was 13.7 bushels of potatoes per acre, or 5.5 per ct. The season of 1914 was not a favorable one in which to make tests of the effectiveness of spraying for potato diseases for the potato foliage was remarkably free from disease of all kinds.

Under these conditions large returns from spraying could not be expected. However, the absence of a killing frost until late in October lengthened the usual period of growth and gave the bordeaux mixture a good opportunity to exert its stimulating influence. It is not clear why the gain from the spraying was not larger.

An investigation of the stem-rot and leaf-spot of clematis.— An investigation of these conditions, reported in Technical Bulletin 44, has shown that both are due to the same cause, namely, the fungus *Ascochyta clematidina.* Stem-rot has been produced by artificially inoculating plants with mycelium from pure cultures of the fungus; and leaf-spot has been produced by spraying plants with liquid containing spores of the fungus.

Experiments on methods of control have demonstrated the importance of thorough ventilation and the prompt removal of diseased parts of plants. In the field, the spraying of plants supported by stakes or wires is of doubtful value; but unsupported plants, cuttings in greenhouses, and young plants in beds may be protected by spraying them with a mixture containing one pound of laundry soap and six pounds of sulphur in fifteen gallons of water. However, the use of excessive quantities of this mixture or of sulphur dust are to be avoided since the accumulation of large quantities of sulphur in the soil may seriously injure the plants.

Seed inspection.— The Botanical Division has in charge the testing of the official samples of seeds sent to us for examination by the Department of Agriculture and also the testing of samples sent in to us by farmers. The amount and results of this work have been reported under the head of " Inspection."

The cooperative experiments of this Division during 1915 has been along two lines only:

Spindling-sprout disease of potatoes: F. A. Sirrine, Riverhead.
W. S. White, Cadyville
Control of bean anthracnose: B. E. Smalley, Interlaken.

CHEMICAL DIVISION.

The majority of the members of this division are engaged in the routine work of analyzing samples of fertilizers, feeds, fungicides and insecticides sent to the Station by the Commissioner of Agriculture in accordance with the provisions of the Inspection Laws. A statement of the amount of work thus performed is included in the figures previously given under the head of " Inspection."

Judging from the number of requests which come from manufacturers and dealers, it would appear that an impression prevails more or less that it is the duty of the Station to analyze samples of fertilizers and feeding stuffs whenever sent in, without reference to the source. It should be clearly understood that the Station cannot undertake analyses for private parties unless such a service is of general benefit. It is entirely out of the question to undertake the work of the manufacturers and the standardizing of their commodities. Analyses of samples sent in by private individuals are practically always declined, first, because the materials represented are in most cases inspected by the Commissioner of Agriculture and, second, because the samples sent are not taken in such a way as to insure a fair representation of the goods sampled. Whenever a body of farmers purchases a large quantity of materials, like fertilizers and cattle foods, on a contract, with a given guarantee of composition, the Station is always willing to undertake an analysis of samples but must insist that these samples be taken in a way that will insure a fair representation of the goods sampled.

Observations on milch goats.— During the past few years the Station has maintained a herd of milch goats for the purpose of studying not only the cost of maintenance but also the adaptability of the milk to certain uses. The most striking results so far secured relate to the feeding of goats' milk to infants. The Station has had the opportunity of supplying this milk to a fairly large number of very young children who were in serious physical condition, due to their inability to properly digest and assimilate either modified cow's milk or any of the commercial infant's foods that were tried. In nearly all cases of this kind the physical condition of the children has been built up and satisfactory growth has been brought about by the use of the goat's milk. It is not entirely clear why this milk has proved to be so efficient a food in the instances under observation. As an attempt to secure information on this point, the milk of several goats has been subjected to a very exhaustive chemical examination. Some very marked differences between goat's milk and the human and cow's milk have been brought out, but it cannot be said, however, that we at present know whether these differences are an explanation of the difference in nutritive effect. Following is a brief and somewhat technical statement of the differences observed.

The composition of goat's milk.— Analyses were made of several samples of milk from each of twelve animals. The fat varies from 1.8 to 8.4 per ct., averaging 3.82 per ct.; the total solids, from 9.22 to 17.63, averaging 12.12 per ct.; the total proteins, from 2.24 to 5.21, averaging 3.21 per ct.; the casein, from 1.56 to 4.06, averaging 2.40 per ct.; the ash, from 0.40 to 0.80, averaging 0.55 per ct.

A study of the casein of goat's milk shows that it is exactly like casein of cow's milk in respect to the number and kinds of compounds it forms with bases. Sugar, and potassium, sodium and chlorine compounds are in solution. Albumin, inorganic phosphates, calcium, magnesium and citric acid compounds are partly in solution and partly in suspension or colloidal solution. Fat and casein are entirely in suspension or colloidal solution. The real acidity of goat's milk is less than that of cow's milk.

Comparing goat's milk with cow's milk and human milk, in respect to their salts, goat's milk contains tri-calcium phosphate, di- and tri-magnesium phosphates, none of which is contained in cow's milk or human milk. It contains potassium citrate in common with cow's milk and human milk, though in larger amounts, but contains no sodium citrate. The chlorine in goat's milk is combined as chloride with potassium, sodium and calcium, while only the calcium chloride is present in cow's milk and human milk. Human milk contains only soluble phosphates, while the other milks contain both soluble and insoluble phosphates.

ENTOMOLOGICAL DIVISION.

One of the most important functions of the Station lies in aiding the farmers and fruit growers of the State to defend themselves against various insect pests. Few persons who have not given the subject careful consideration appreciate the immense loss occasioned to agriculture by the depredations of insects, and likewise we can hardly overestimate the saving which has been made through the methods of prevention of such depredations worked out by Experiment Stations. If science had not come to the rescue when the potato beetle began its advance from the West to the East or if there had not been a prompt study of the means of control the San José scale which at one time appeared to seriously threaten the apple industry of New York, the potato growers and apple growers would have had little encouragement in their business. What is true of these two pests is true of many others.

The Entomological Division of the Station gives its attention mainly to such defense work, but at the same time it follows the wise policy of working out the life history of insects and studying severely some of the fundamental problems that relate to insect life. During 1915 several publications have been issued dealing with the problems of economic entomology.

The control of plant lice in apple orchards.— One of the most difficult problems confronting fruit growers is the control of the aphides or plant lice that are injurious to apple foliage and fruit. This matter has been the subject of long-continued study, and it must be said that so far we are not able to suggest any entirely satisfactory methods of controlling this pest. Some of the measures commonly advocated are strikingly at variance with experience and practice. The Station experiments have shown that applications of various insecticides, including lime-sulphur which is widely recommended to kill aphis eggs, are of doubtful utility. Spraying when the insects appear in injurious numbers has in the main given very unsatisfactory results because of the difficulty of reaching appreciable numbers of the insects. Moreover, if the treatment is too long delayed the young apples are liable to attack and to receive injuries from which there is no recovery. Attempts to destroy fall migrants and egg-laying females have likewise been attended with unsatisfactory results because of certain practical difficulties, and furthermore spraying so late in the season has not met the approval of commercial growers. Bulletin No. 402 contains an account of initial experiments against the insects, which indicate that while the problem of controlling the insects is a difficult one the most important step for the prevention of injuries is the destruction of the plant lice on the expanding buds.

Tree crickets.— An investigation of these insects was undertaken in order to ascertain the rôle that they play in the dissemination of various bark disorders of fruit trees. During this investigation the life history and bionomics of several species of tree crickets were given careful study. While many of the technical facts brought out do not now appear to have any direct relation to orchard practice, it was established that this form of insect life is an agent in the spread of bark diseases of fruit trees.

The cherry and hawthorn sawfly leaf-miner.— The Station entered upon an investigation to determine the cause of the disorder of the foliage of the English Morello cherry, which is characterized by light-colored blister-like areas due to the destruction of the pulpy tissues. Studies by this Station have shown that this injury is caused by a leaf-mining insect (*Profenusa collaris* MacGillivray). This proves to be a new orchard pest in New York and one not heretofore recorded as injurious to fruit plantings in this country.

The adult insect is a small sawfly which varies from one-eighth to one-sixth of an inch in length. The injury to foliage by this species is due to the work of the larvæ which mine the leaves and destroy the mesophyl or pulpy tissues. Frequently the entire leaf is mined, but usually only from one-quarter to one-half of the leaf area is destroyed. The leaves that are most seriously affected shrivel and die, and finally drop to the ground. Besides the English Morello cherry the pest also attacks certain species of Crataegus and may greatly reduce the attractiveness of hawthorns for ornamental purposes.

Two parasites were bred from the sawfly — *Trichogramma minutum* Riley, reared from the eggs of the pest, and *Pezoporus tenthredinarum*, which is an internal parasite of the larval and pupal stages and proves to be a new species.

In experiments to check the mining of cherry leaves the larvæ of the sawfly proved to be very resistant to lime-sulphur solution, naphthalene, kerosene emulsion, miscible oil, nicotine solution, kerosene or gasoline. Picking of affected leaves at first appearance of injury and destruction of hawthorns in the vicinity of cherry orchards are advised tentatively as the most practical means of avoiding injuries to cherries by the leaf-miner. Plowing and cultivation, especially during late April or early May, would doubtless destroy many of the insects in the ground, although the exact value of this practice has not been determined. Fumigation with hydrocyanic-acid gas proved to be the only direct treatment of the foliage which effectually checked the destructive work of the larvæ in cherry leaves. An application of nicotine solution and soap when the young larvæ are beginning to tunnel the foliage apparently affords efficient protection to hawthorns.

The grape root-worm.— The Station has given long-continued study to this pest because its successful control is one of the most serious problems that confronts the grape growers in the Chautauqua and Erie grape belt. The studies by the Station indicate that this pest is not as difficult to control as many growers have believed to be the case. There has been brought to the attention of vineyardists the conditions under which the insect in its various life stages is most susceptible to remedial and repressive measures. It is believed that an intelligent application of the published recommendations will usually hold the pest in control. The following are the recommendations:

If the beetles are not very numerous spray within a week after the appearance of the first beetles, using bordeaux mixture (8–8–100) and arsenate of lead 6 lbs. Repeat this spraying in about ten days. The vines should be thoroughly sprayed. If the beetles are numerous spray as soon as the beetles appear in numbers on the vines, being careful to avoid applying just before a rain, with arsenate of lead 6 lbs., molasses 1 gallon and water, 100 gallons. A cheap stock molasses is better than the more refined grades. Spray a second time one week later, using bordeaux mixture (8–8–100) and arsenate of lead 6 lbs. The object in using the sweetened spray is to kill as many beetles as possible with the first application and by means of the second spray to repel what may remain as well as others migrating from other vineyards. Inasmuch as the beetles are more active during warm days, better results have been obtained by applying the molasses mixture on such days providing rains were avoided.

Sinuate pear borer and leopard moth.—The Station has made a study of two destructive pests that are being shipped into the fruit-growing sections of the State through importation of nursery stock. These insects are the sinuate pear borer and the leopard moth. Suggestions have been published as to their control. It is possible that the sinuate borer may be successfully controlled by an application of an arsenical spray during the latter part of May or shortly before the beetles commence to appear. An application of some wash to the trunks and branches of the trees during early June as a deterrent to egg laying is worthy of trial. These measures are tentatively suggested pending the results of other investigations.

The damage from the leopard moth is caused by the larva or grub of this species which inflicts serious injury to branches and trunks by tunneling into them. The measures employed to combat this pest are in general such as are commonly practiced against wood-boring insects: Prune and cut back infested branches and destroy caterpillars in their mines. In case of attack of the twigs and tips of branches by young larvae remove a few inches of the end of the new growth. Systematically examine trunks and large limbs for "borers" which should be cut out and destroyed. Caterpillars buried deeply in the heart-wood should be killed by probing with a piece of wire or by injecting carbon bisulphide into the burrows, when the openings after application should be immediately sealed with moistened clay or putty. Infested nursery stock should be burned.

COOPERATIVE WORK.

Nature of Activity.	Cooperator.	Location.
Control of pear thrips	A. W. Hover & Bro	Germantown.
	W. Ten Broeck	Hudson.
Control of pear midge	W. Ten Broeck	Hudson.
Control of pear psylla	David Enos	Oswego.
	J. Glerum	Oswego.
	Eugene Sheldon	Oswego.
	H. Sheldon	Oswego.
	Frank Place	Oswego.
	E. C. Dexter	Oswego.
	Oliver Robarge	Oswego.
	E. J. Lonis	Hannibal.
	W. E. Hall	Hannibal.
	H. Barnhardt	Oswego.
	J. Kampel	Hannibal.
	James Bremner	Oswego.
	William Ruttan	Oswego.
	S. N. Sweet	Oswego.
	T. G. Newton	Oswego.
	John Crites	Oswego.
	Charles Ladley	Oswego.
	E. B. McGlen	Hannibal.
	Asa Pease	Oswego.
	Ralph Pierce	Oswego.
	Spencer Brownell	Oswego.
	C. E. Sayer	Oswego.
	D. A. Griswold	Oswego.
	D. D. Stone	Oswego.
	W. S. Rappleye	Oswego.
	Fred Hammond	Geneva.
Control of apple aphides	E. S. Gifford	Gasport.
	C. D. Tabor	Wilson.
	B. S. Harwood	Appleton.
	F. L. Backus	Olcott.
	H. H. Freeman	Kent.
	John Larwood	Albion.
	John Beckwith	Lyndonville.
	B. G. Gibson	Albion.
	G. E. Snyder	Albion.
	Lynn Burrows	Albion.
	John Beckwith	New Haven

Nature of Activity.	Cooperator.	Location.
Control of grape root-worm	Fred Denson	Dunkirk.
	J. T. & N. G. Merritt	Dunkirk.
	R. H. Roberts	Silver Creek.
	Omar Smith	Westfield.
Control of grape-berry moth	Eugene Bacon	Westfield.
Control of rose chafer	Louis Bourne	Westfield.
Control of cherry-leaf beetle	R. J. Paschke	Fredonia.
	D. B. Belden	Fredonia.
Control of cranberry toad-bug	R. C. Brown, (20 acres)	Calverton.
	S. M. Woodhull, (25 acres)	Riverhead.

HORTICULTURAL DIVISION.

It has previously been noted that agronomy, which relates more particularly to the growing of field crops, is a comprehensive subject, and broadly speaking relates itself to nearly all fields of physical and biological science. The same may be said of horticulture as dealing with fruit and vegetable culture. Chemical, physical and biological problems enter into horticultural studies. But with horticulture, as with agronomy, its problems must be worked out through a correlation of the efforts of a number of scientific specialists. The studies of the Horticultural Division in this Station are given chiefly to questions of plant breeding, orchard management and the varieties of fruits.

Investigations concerning which publications have been issued are the following:

Effects of various dressings on pruning wounds of fruit trees.— Fruit growers have long used paints, tars, waxes and other substances as coverings for wounds of trees. A report has been made on the effects of these various substances on wounds made on the apple and on the peach. In all cases undressed pruning wounds have healed more rapidly than those whose surfaces have been protected. Of all the materials used, shellac was least injurious. On the other hand, it adheres to the wounded surfaces least well of all.

Nothing is to be gained in the treatment of wounds in waiting several weeks before applying any of the various dressings used in these experiments. There is nothing to show in this experiment that it is worth while to treat wounds, large or small, of fruit trees with any of the substances in common use. It may develop that the wood exposed in the larger wounds will be saved somewhat from the decay which often sets in on exposed wood of fruit trees; in which case white lead is undoubtedly the best dressing to use.

Strawberry varieties.— Bulletin No. 401 is a report on varieties of strawberries tested at this Station during the past three years. The kinds grown include, for most part, new varieties with standard commercial sorts for purposes of comparison. All varieties received the same general treatment during the three years, the matted-row system being followed. The soil at this Station is a cold, heavy, clay loam, not well adapted to the strawberry.

The bulletin gives the blooming season, season of ripening, sex of flowers, names the best plant-makers, states the relative productiveness, gives the vigor of plant, compares the resistance of varieties to disease and compares the size and quality of the varieties tested.

New or noteworthy fruits.— Bulletin No. 403 contains a description of new or noteworthy fruits. This is the third report of this kind from the New York Agricultural Experiment Station. The objects of these reports are: To describe the best recent fruit introductions and to call attention to noteworthy sorts which, though old, have not received the attention they deserve. In the first two reports it was emphasized that fruit growing would be at a standstill if it were not for the new varieties since old sorts have not been and cannot be improved. In this third discussion of new varieties it seems more important to discuss in the introductory remarks the relative value of new and standard varieties of fruits for commercial planting. Following this brief discussion, the various fruits thought to be worthy of attention are described. These are: the Niagara peach, the Muscat Hamburg grape, Lambert cherry, Late Muscatelle plum, Industry gooseberry, Black Pearl and Marldon raspberries and the Amanda strawberry.

Dwarf apples.— At the request of the horticultural societies of New York, this Station undertook a comparative test of dwarf and standard apple trees. Bulletin No. 406 is a final report of the test which was carried on for ten years. For the standard trees French crab stocks were used; for the dwarfs Doucin and French Paradise stock. Sites were selected for the test with reference to climate and soil as follows: Kinderhook, Columbia County; Fayetteville, Onondaga County and Carlton, Orleans County. The care taken of the orchards was that commonly given commercial orchards in New York except in the matter of pruning. Summer pruning is part of the recognized yearly treatment of dwarf trees. The results show:

1st.— That the union between stock and cion is poorer with Doucin and French Paradise stocks than with the French Crab and that varieties unite less well on French Paradise than on Doucin stocks.

2nd.— Doucin and French Paradise stocks are less hardy than French Crab, and of the two dwarfs French Paradise is much less hardy.

3rd.— The greatest weakness of the dwarfing stock for New York is the surface-rooting habit, in which character the two stocks can not be distinguished.

4th.— Suckers from both dwarfing stocks proved much more troublesome than with the standard trees.

5th.— The trees on the three stocks attain the size commonly ascribed to them; those on French Crab are full sized; on Doucin, half dwarf; on French Paradise, true dwarfs. In this test the dwarfing effect of the dwarf stock was not as marked as is commonly reputed. We conclude that distances apart commonly recommended for dwarf trees bring them much too close; in New York Doucins should be set half and the true dwarfs one-third as far apart as standard trees. If the cion is permitted to strike root, greater distances must be allowed.

6th.— Trees on French Paradise come in bearing soonest, Doucin next and French Crab last.

7th.— The test has not been such that a safe conclusion can be drawn as to which stock makes the most productive orchard.

8th.— There were no marked differences in size, color and quality of the apples on the three stocks.

9th.— The advantages of dwarf trees appeal to amateur rather than professional apple growers. Thus, the trees take less space and therefore permit a greater variety in orchard or garden and they are handsomer ornamentals.

The blooming season of hardy fruits.— In 1908 this Station published blooming data for 866 varieties of tree and vine fruits. In the seven years that have elapsed many new varieties of the tree and vine fruits have been grown for which we now have data as we have also for bramble and bush fruits and strawberries. Bulletin No. 407 assigns the blooming season from data taken at this Station for all of the varieties of fruits commonly grown in New York. The data presented cover the past five years.

Besides the data for the several fruits there is a discussion of the value of such data and a consideration of such subjects as: The effects of different temperatures on the essential organs of flowers; the effects of moisture on the essential organs; the variability in blooming season; the influence of location on blooming time and the comparative blooming dates of the several different fruits.

Ripening dates and length of season of hardy fruits.— Accurate knowledge of time of ripening and length of season of varieties is information that the commercial fruit grower must have. It is not sufficient that he know roughly what the season of his fruits is. To take the turn of the markets he should know exactly when a variety will ripen and how long it will keep. Yet current data on fruit maturity are notoriously unreliable. Bulletin No. 408 from this Station gives the dates of maturity of the various fruits in this climate as they ripen on the Station grounds besides which are discussed: The ripening time of fruits; variability in ripening dates and keeping quality; the correlation between blooming time and ripening time; the conditions affecting ripening time in the Station orchards.

Inheritance of certain characters of grapes.— Technical Bulletin No. 45 discusses the results obtained during the past twenty-five years in breeding nearly ten thousand seedling grapes at the Geneva Experiment Station. The work has progressed mainly along two lines: (1) The determination of the breeding possibilities of varieties of grapes and (2) the study and interpretation of breeding phenomena. Nearly 200 varieties of grapes have been used in the breeding work. The usual method of emasculation has not been effective in a few cases and may be open to criticism. One of the surprises in the study of grape varieties was the failure of many commercial sorts to transmit desirable qualities. In order to study grape varieties, nearly 3,000 selfed, or pure, seedlings have been grown. These are uniformly lacking in vigor. The inheritance of those grape characters which have sufficient data available has been discussed in this paper. Of the two types of stamens, reflexed and upright, the first is correlated with complete, or nearly complete, self-sterility, the second with self-fertility. Self-sterility is probably caused by impotent pollen. It exists in varying degrees and depends to some extent upon the condition of the vine and environmental factors. Self-sterile varieties of grapes being undesirable from a horticultural standpoint, can we eliminate those with reflexed stamens? The following crosses have given upright and reflexed stamens in the indicated ratios:

U x U = 4.3 U:1R
R x R = 1.2 U:1R
R x U = 1U:1R
U x R = ?

Breeding from the upright varieties only will decrease but not eliminate the seedlings with reflexed stamens. The following seem to be the results secured in the study of sex inheritance:

Hermaphrodite female x hermaphrodite male = all hermaphrodites.

Hermaphrodite female x pure male = ½ hermaphrodites plus ½ males.

Two general laws have been formulated with regard to color of the skin: (1) White is a pure color; and (2) it is recessive to both black and red. No black variety has proved pure for blackness. Some contain white, others white and red. Red varieties are equally diverse. The colors of pure seedlings of certain varieties show wide variation, even when derived from varieties of similar color. In the inheritance of quality the most noticeable thing is the low percentage of seedlings whose quality is good or above good. This is probably due to the leveling influence of the wild ancestors from which the seedlings are but a step removed. Most grapes of high quality possess some *Vitis vinifera* blood. The pure seedlings on the New York Station grounds have been lower in quality than crossed seedlings. In the inheritance of size of berry there is no indication of dominance of any one size, though there is a tendency for a variety to produce seedlings approaching its own size. The oval form of many *Vitis vinifera* hybrids is probably an intermediate between round and a more pronounced oval. The season of ripening of the parent influences to a considerable extent the season of the offspring. A vineyard of 1,500 seedlings bred from 1898 to 1903 has dwindled through selection to less than 75. Of these, five have already proved promising enough to be named.

Various circulars have been issued on the following subjects: Raspberries, Blackberries and Dewberries; Tomato Culture; Hot and Cold Frames; Culture of the Potato; Rhubarb Culture; Onion Culture; Gooseberry Culture; Dahlias and Their Culture; and the Soy-Bean and Cow-Pea.

These circulars have been provided as a means of replying to inquiries that are made of the Station along these various lines and are not intended for general circulation. They will be issued to persons who make specific inquiries that come within the scope of any one of these circulars.

The circular on Dahlias and Their Culture is the first publication of the Station for a long time dealing with a floricultural subject. This circular has met with great commendation and it would be well if the Station had the funds with which to give attention to the varieties and care of flowers. Flowers certainly constitute an important factor in our lives, especially in adding to the attract veness of our homes and gardens.

COOPERATIVE EXPERIMENTS CONDUCTED IN 1915

Experiments with Grapes

Fertilizer, cultural and pruning experiments, H. B. Benjamin, Fredonia.
Fertilizer, cultural and pruning experiments, E. M. Foster, Urbana.

PUBLICATIONS ISSUED DURING 1915.

BULLETINS.

No. 394. January. Seed tests made at the Station during 1914. M. T. Munn. Pages 27.
Popular edition, pages 4.

No. 395. February. Further studies on the spread and control of hop mildew. F. M. Blodgett. Pages 52, plates 2, figs. 2.
No popular edition issued.

No. 396. February. Effect of various dressings on pruning wounds of fruit trees. G. H. Howe. Pages 12.
Popular edition, pages 2.

No. 397. February. Lime-sulphur vs. bordeaux mixture as a spray for potatoes. III. M. T. Munn. Pages 11, plates 2.
Popular edition, pages 2.

No. 398. March. Milk quality as determined by present dairy score cards. James D. Brew. Pages 26, chart 1.
Popular edition, pages 11, chart 1.

No. 399. March. The spindling-sprout disease of potatoes. F. C. Stewart and F. A. Sirrine. Pages 11, plates 3.
Popular edition, pages 4.

No. 400. March. Ground limestone for acid soils. J. F. Barker and R. C. Collison. Pages 19, plate 1.
Popular edition, pages 8.

No. 401. March. Strawberry varieties. O. M. Taylor. Pages 28.
Abridged edition, pages 8.

No. 402. April. The status of spraying practices for the control of plant lice in apple orchards. P. J. Parrott and H. E. Hodgkiss. Pages 18, plates 2, figs. 2.
Popular edition, pages 7, figs. 2.

No. 403. April. New or noteworthy fruits. III. U. P. Hedrick. Pages 10, colored plates 4.
No popular edition issued.
No. 404. April. Inspection of feeding stuffs. Pages 114.
No popular edition issued.
No. 405. May. Potato-spraying experiments at Rush in 1914. F. C. Stewart. Pages 5.
No popular edition issued.
No. 406. May. Dwarf apples. U. P. Hedrick. Pages 28, plates 7.
Popular edition, pages 8, plates 2.
No. 407. May. The blooming season of hardy fruits. U. P. Hedrick. Pages 25.
No popular edition issued.
No. 408. June. Ripening dates and length of season for hardy fruits. U. P. Hedrick. Pages 25.
No popular edition issued.
No. 409. August. Germ content of stable air and its effect upon the germ content of milk. G. L. A. Ruehle and W. L. Kulp. Pages 56, figs. 4.
Popular edition, pages 10.
No. 410. October. Report of analyses of samples of commercial fertilizers collected by the Commissioner of Agriculture during 1915. Pages 76.
No. 411. December. The cherry and hawthorn sawfly leaf-miner. P. J. Parrott and B. B. Fulton. Pages 30, plates 6, figs. 9.
Popular edition, pages 4, plates 2.
No. 412. December. Pasteurization of dairy by-products. W. D. Dotterrer and R. S. Breed. Pages 30.
Popular edition, pages 8.
No. 413. December. Director's report for 1915. W. H. Jordan. Pages 42.
No popular edition issued.

TECHNICAL BULLETINS.

No. 40. January. Concerning the organic phosphorus compound of wheat bran and the hydrolysis of phytin. R. J. Anderson. Pages 31.
No. 41. April. Fibrin. Alfred W. Bosworth. Pages 6.
No. 42. May. The tree crickets of New York: Life history and bionomics. Bentley B. Fulton. Pages 47, colored plates 4, plates 2, figures 21.
No. 43. May. Human milk. Alfred W. Bosworth. Pages 3.
No. 44. August. *Ascochyta clematadina*, the cause of stem-rot and leaf-spot of clematis. W. O. Gloyer. Pages 14, plates 5.
No. 45. August. Inheritance of certain characters of grapes. U. P. Hedrick and R. D. Anthony. Pages 19.
No. 46. December. The casein and salts of goat's milk. Alfred W. Bosworth and Lucius L. Van Slyke. Pages 15.
No. 47. December. Limestones of New York with reference to their agricultural use. R. C. Collison and J. F. Barker. Pages 36, plates 6, charts 2, colored map 1.

CIRCULARS.

(Not intended for general distribution).

(See p. 619.)

No. 33. January 25. Raspberries, blackberries and dewberries. O. M. Taylor. Pages 10.
No. 34. January 20. Tomato culture. J. W. Wellington. Pages 3.
No. 35. January 25. Hot and cold frames. J. W. Wellington. Pages 4.
No. 36. January 20. Culture of the potato. J. W. Wellington. Pages 4.

No. 37. February 15. Second distribution of Station apples. U. P. Hedrick. Pages 2.
No. 38. March 20. Rhubarb culture. C. C. Carstens. Pages 4.
No. 39. April 20. Alfalfa on land not naturally adapted to that crop. J. F. Barker. Pages 8.
No. 40. April 30. Onion culture. J. W. Wellington. Pages 6.
No. 41. June 21. The grape root-worm. F. Z. Hartzell. Pages 6, plates 2, figs. 4.
No. 42. August 2. Guide to buildings and grounds (of the Station). Pages 6.
No. 43. November 30. Dahlias and their culture. F. H. Hall. Pages 24, plates 8.
No. 44. December 1. The sinuate pear borer and the leopard moth. P. J. Parrott and Hugh Glasgow. Pages 3.
No. 45. December 20. Soy-bean and cow-pea. F. H. Hall. Pages 6.
No. 46. December 28. Gooseberries. O. M. Taylor. Pages 5.

W. H. JORDAN,
Director.

NEW YORK AGRICULTURAL EXPERIMENT STATION
GENEVA, N. Y., December 31, 1915.

REPORT

OF THE

Department of Agronomy.

J. F. **Barker**, *Agronomist.*

R. C. **Collison**, *Associate Agronomist.*

[1] R. F. **Keeler**, *Assistant Chemist.*

[2] A. J. **Lewis**, *Assistant Chemist.*

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[1] To November 1.

[2] Appointed November 8.

REPORT OF THE DEPARTMENT OF AGRONOMY.

GROUND LIMESTONE FOR ACID SOILS.*

J. F. BARKER AND R. C. COLLISON.

SUMMARY.

In the first section of this bulletin, the chemical composition of limestones is discussed briefly, with a table showing the carbonate content and calcium carbonate equivalent of the ground limestones produced in the various quarries of the State and of the principal ones brought in from outside. The limestone formations of the State will be fully treated in a later bulletin of the Station.

In following sections are given a discussion of the practical use of ground limestone on acid soils, an estimate of the proportion of soils in the State requiring liming, and compiled data showing the returns from the use of limestone on various crops and soils. The amounts of lime needed and methods of applying it under different conditions are fully discussed. Next, burned lime and limestone are compared as correcters of soil acidity, with notes on the relation of magnesium in limestone to its practical use.

Under the heading "Fineness of ground limestone," theoretical considerations and experiments in its use are given to show that fineness greater than necessary to allow all the material to pass through a ten-mesh sieve is not required for satisfactory use.

The bulletin closes with a brief discussion of the nature and origin of soil acidity.

COMPARATIVE VALUE OF DIFFERENT LIMESTONES.

Limestones are made up of calcium carbonate or calcium and magnesium carbonates and a varying amount of clay-like material. The better grades run above 90 per ct. total carbonates. All limestones contain a higher precentage of calcium carbonate than magnesium carbonate, the latter varying in different stones from nothing to a maximum of about 45 per ct. Those containing 10 per ct. or more magnesium carbonate are usually referred to as magnesium limestones and if they carry near the maximum amount they are also called dolomites.

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* A reprint of Bulletin No. 400, March, 1915.

According to the present state of our knowledge, magnesium limestones are fully as effective as straight calcium stones for practical use in soil improvement. In fact, a given weight of magnesium carbonate is capable of neutralizing somewhat more acidity than the same weight of calcium carbonate, 100 pounds of the former being equal to 119 pounds of the latter in this respect. The comparative value of different limestones for use on the soil is conveniently expressed in terms of their *calcium carbonate equivalents.* This figure is simply obtained by adding to the percentage of calcium carbonate the percentage of magnesium carbonate multiplied by 1.19, since one pound of magnesium carbonate is chemically equivalent to 1.19 pounds of calcium carbonate; thus a stone containing 76 per ct. calcium carbonate and 20 per ct. magnesium carbonate would have a calcium carbonate equivalent of 99.8. This figure will usually be but little different from that for the percentage of total carbonates.

The buyer of ground limestone is often confused by certain firms or individuals insisting upon the especial merits of some particular product. He should note the figure for calcium carbonate equivalent and bear in mind that, assuming reasonable fineness, this gives the comparative value of the product. If a stone showing a calcium carbonate equivalent of 90 can be delivered to the buyer's railway station for $1.80 per ton, then one having an equivalent of 100 is scarcely worth more than $2 per ton; the two are valuable in the proportion of 90 to 100, allowing only for the slightly greater amount of work in hauling and applying a given quantity of lime in the lower grade stone.

For a classification and description of the limestone formations of the State, together with a map showing extent and location of same, the reader is referred to a forthcoming bulletin of this Station.

The usual method of limestone analysis determines total calcium and magnesium without regard to the form in which they exist in the stone, it being taken for granted that all is in the carbonate form. The methods used in obtaining the above analyses take account only of the carbonates in limestone, the part effective for neutralizing soil acidity, and so the figures for calcium carbonate equivalent are from 0 to 3 per ct. lower than would be obtained by total analyses.

The bases for these analyses are, in the case of companies in the State, samples taken by a representative of the Station directly from the storage bins of the company and also from carloads shipped to farmers. The figures given are the average of from two to six samples.[1] Samples from companies outside the State have been collected from carloads shipped to New York farmers and have been taken either by a representative of the Station or of the State Department of Agriculture or by one of the County Farm Bureau men.

THE PRACTICAL USE OF GROUND LIMESTONE.

Crops sensitive to acid soils.— Nearly all general farm crops are sensitive to an acid condition or a lack of carbonates in the soil, and thrive much better if a certain amount of lime carbonate is present. As is well known, some of these, particularly alfalfa, clover, blue grass, timothy, beans, beets, and others can scarcely be grown with success unless the soil contains a liberal amount of carbonates. A few plants actually do better on an acid soil: for instance, blueberry, cranberry, serradella and the common sorrel. In practical farming such a great majority of the crops to be grown do better on well-limed soils that it is unprofitable to have the soil in an acid condition, provided only that limestone can be obtained at an economical price. Contrary to a common impression, potatoes require a fair amount of carbonates for their best development, and since they should always be grown in a rotation with other crops usually including clover or alfalfa it is out of the question to keep the soil acid for the sake of making it easier to combat the potato scab. The use of cover crops, especially legumes, emphasizes the importance of lime in connection with fruit-growing. Comparatively little data is available as to the direct effect of liming on the growth of various fruits, but in general it is known that the tendency of lime is to check excessive wood growth and promote fruitfulness.

Soils of the State in need of liming.— Three-fourths or more of the farm lands of New York State would be greatly benefited by a liberal application of lime in some form. In fact, such a treatment is fundamental to any rational method for the improvement of these soils. This is coming to be so generally recognized by practical farmers and it is a matter of such frequent discussion that it need not be advocated at length here.

The soils not at present in need of liming are those which have been naturally well stocked with limestone by reason of their having

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[1] The analyses reported in this bulletin have been made by R. E. Keeler, Assistant Chemist.

COMPOSITION OF GROUND LIMESTONE FOR SALE IN NEW YORK STATE.

Name of company.	P. O. address.	Location of quarry.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Calcium carbonate equivalent.	Geological formation.
Adams & Duford Co... ..	Chaumont........	Chaumont........	92.9	.7	93.6	93.8	Lowville limestone.
B. & B. Lime & Stone Co.	Mellenville.......	Mellenville.......	70.3	7.7	78.0	79.4	Manlius limestone.
Buffalo Cement Co.......	Buffalo...........	Buffalo...........	52.0	39.0	91.0	98.3	Cobleskill dolomite limestone.
Beardsley, W. S., & Co...	Auburn..........	Auburn..........	84.5	2.9	87.3	88.0	Onondaga limestone.
Burkdorf, H. J...........	St. Johnsville.....	St. Johnsville.....	89.4	3.0	92.4	92.9	Trenton limestone.
[1] Caledonia Chemical Co...	Caledonia........	Caledonia........	85.0	1.6	86.6	86.9	Marl.
Callanan Road Imp. Co...	South Bethlehem..	South Bethlehem..	75.2	6.3	81.5	82.7	Manlius limestone.
Canajoharie Stone Co.....	Canajoharie......	Canajoharie......	78.8	6.6	85.4	86.7	Glens Falls limestone.
Chazy Marble Lime Co....	Chazy...........	Chazy...........	91.1	2.2	93.3	93.7	Valcour limestone.
Conley Stone Co.........	Utica...........	Munnsville.......	94.1	.3	94.4	94.5	Manlius limestone.
Conley Stone Co.........	Utica...........	Blakeslee.........	91.0	1.8	92.8	93.2	Manlius limestone.
Dutchess Co. Lime Co....	Dover Plains.....	Dover Plains......	53.8	34.0	87.8	94.1	Stockbridge limestone.
DeVoe Limestone Co.....	Accord..........	Accord..........	68.3	10.3	78.6	80.5	Decker's Ferry limestone.

Frets, M. W.	Richfield Springs	Richfield Springs	89.7	.4	90.1	90.1	Onondaga limestone.
Geneva Limestone Co.	Geneva	Oaks Corners	59.7	28.4	88.1	[2]93.4	Cobleskill limestone.
Harris, John	Saratoga Springs	Rollins Hollow	88.1	3.0	91.1	[3]91.7	Glens Falls limestone.
Langdon & Co.	Elmira	Pekin	84.8	6.6	91.4	92.6	Wolcott limestone.
LeRoy Limestone Co.	LeRoy	LeRoy	89.1	1.7	90.8	91.2	Onondaga limestone.
Medina Limestone Co.	Medina	Medina	53.7	43.3	97.0	105.1	Lockport dolomite limestone.
Norton Stone & Lime Co.	Cobleskill	Cobleskill	75.9	2.2	78.1	78.5	Coeymans limestone.
Otsego & Herkimer R. R. Co.	Cooperstown	Cullen	88.9	1.5	90.4	90.7	Onondaga limestone.
Rock Cut Stone Co.	Syracuse	Rock Cut	70.3	15.0	85.3	88.1	Manlius limestone.
Roberts, George H.	17 State st., New York City	LaGrangeville	56.2	36.5	92.7	99.5	Wappinger limestone.
Sasman, Christopher	Salisbury Center	Salisbury Center	89.7	trace	89.8	89.8	Trenton limestone.
Solvay Process Co.	Syracuse	Jamesville	90.1	2.5	92.6	93.1	Manlius limestone.
Smith, N. T.	Sharon Springs	Sharon Springs	91.4	.9	92.3	92.4	Manlius limestone.
Sugar River Stone Co.	Boonville	Boonville	90.9	1.3	92.2	92.4	Lowville limestone.
Upper Hudson Stone Co.	26 Courtlandt St., New York City	Verplanck Point	50.4	34.6	85.0	91.6	Inwood limestone.
Worlock Stone Co.	Canastota	Canastota	93.6	.9	94.5	94.7	Manlius limestone.

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[1] Marl.

[2] Average analysis of samples taken from face of quarry before company began grinding.

[3] Samples sent in by Mr. Harris.

SOME GROUND LIMESTONES FROM NEAR-BY STATES.

Name of company.	P. O. address.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Calcium carbonate equivalent.
Carbon Limestone Co.	Youngstown, O.	88.9	1.2	90.1	90.2
Bessemer Limestone Co.	Youngstown, O.		No sample obtained		
Kelley Island Lime & Transport Co.	Cleveland, O.	75.3	17.8	93.1	96.4
Grangers Lime & Marble Co.	West Stockbridge, Mass.	66.2	16.8	83.0	86.2
Edison Portland Cement Co.	Stewartsville, N. J.	86.3	2.9	89.2	89.8
J. E. Baker & Co.	Bainbridge, Pa.	86.7	5.8	92.5	93.6
Security Cement & Lime Co.	Berkeley, W. Va.	93.7	1.9	95.6	96.0

been derived in large part from limestone formations. Such soils can usually be recognized by fragments of limestone boulders or gravel still remaining in the surface or subsoil and washed out along gutters and streams and along the roadsides. Such land will usually grow alfalfa without much difficulty; and at present, in any community where alfalfa is commonly grown, it can safely be assumed that additional limestone is not much needed. A forthcoming bulletin, showing location of limestone outcrops, will give some indication as to where natural limestone soils are likely to be found. Sections of New York especially in need of liming comprise nearly all of the southern half of the State (excepting parts of Schoharie, Albany, Dutchess, Putnam, Westchester and Orange counties), the lakefront lands bordering Lake Ontario, nearly all of Long Island, and a large proportion of the rest of the state.

Returns from use of limestone.— Phenomenal results are often obtained from the practice of liming the land and, since it is such results that are most talked about and made the subject of photographs, there is some danger that those just beginning the use of limestone may be led to expect too much from it. When attempting to grow certain crops, particularly alfalfa, on acid soils the use of limestone as against using no lime frequently makes all the difference between a success and complete failure, and of course the value of liming in such cases can hardly be overestimated. On very acid soils, such as occur over a large part of this State, the use of liberal amounts of limestone is fundamental to the successful production of most general farm crops, and in view of this the need of limestone has not yet been overestimated and is not likely to be. But in general the practice of liming should be expected to produce results that are mild and lasting rather than phenomenal and short-lived, and its use should be part of a systematic scheme for building up the soil in respect to its content of phosphorus, organic matter and lime carbonate and for improving its physical condition.

The following average results from carefully-conducted experiments on the use of limestone on soils only mildly[1] acid give a fair estimation of what can safely be expected from the use of limestone on land at all deficient in that material:

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[1] The comparison at the Ohio station is against land three-fifths of which had received one application of lime.

At the New Jersey Station one application of two tons per acre of ground limestone gave the following increases per acre of crops grown during a period of five years following: Of grains, corn gave an increase of 4.3 bushels, oats 4 bushels, wheat 6.7 bushels, rye 8.0 bushels; of vegetables, potatoes were not increased, but beans gave a gain of 2.1 bushels, tomatoes 4870 pounds, cucumbers 3500 pounds; of forage crops, oats and peas gave an increase of 400 pounds dry matter, vetch and rape 2750 pounds, timothy and clover 690 pounds, rye and cowpeas 370 pounds.

These crops were grown in four different rotations and the average value of the increase from three rotations, including only general farm crops, is estimated by the New Jersey Station at $25 per acre, while that from the rotation including tomatoes and cucumbers in addition to potatoes, corn and lima beans was $48. In this experiment liming did not increase the yield of potatoes, but on very acid soils it will frequently do so to a marked extent. Noteworthy evidence to this effect has been brought out by the Rhode Island Station.

The Ohio Station[2] reports the results of 12 years' experiments with the use of lime in a 5-year rotation of corn, oats, wheat, clover, timothy. The test was carried out on each of five different fields each year, the lime being used once in a rotation and applied at the time of preparing the land for corn. The first application was burned lime at the rate of one ton per acre, later applications were one ton of ground limestone per acre, making an average of 1½ tons ground limestone or its equivalent. The effect of the limestone can be conveniently stated in terms of the value of average increase for all crops in a 5-year rotation, allowing 60 cents per bushel for corn and its stover, 50 cents for oats and its straw, $1.00 for wheat and straw, and $10 per ton for hay. These figures are, of course, below the market price of the crops, low enough to insure the computations showing net values. In this way it can be figured from the results published by the Ohio Station that the application of lime for a 5-year period has given, when applied alone, average increases in crops worth $15.18. When applied on land receiving acid phosphate the lime has produced increases worth $17.23; on land receiving acid phosphate and potassium the increase from liming has been $20.31;

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[2] Ohio Agr. Exp. Sta. Bul. 279.

on land receiving complete commercial fertilizer $20.21, and on land receiving barnyard manure $19.63.

Lime does not take the place of fertilizers or manure.— The Ohio experiments illustrate the fact that lime does not take the place of other fertilizers or manures, but supplements them. Contrary to the generally accepted theory of its tendency to liberate potassium, it seldom has any practical effect of this kind. The above results show very strikingly that when limestone and fertilizers are used on the same land the effect is greater than the sum of the effects from the two used separately. Thus the sum of the values of increase from lime and acid phosphate when used on separate plats has been $38.58 per acre for each 5-year rotation, but when used together the increase has been worth $40.83. Lime and a combination of phosphorus and potassium, when used separately, have given a total increase worth $49.15. When used together the value of increase has been $54.28. The total increase from lime and complete fertilizer used separately was $57.19; used in combination $61.22. Lime and manure (16 tons per acre) used separately have produced increases worth $77.08; when used on the same land the figure is $81.53.

When the use of lime in any form is continued alone and no adequate provision made for maintaining the supply of other fertilizers and organic matter, crop yields cannot be kept up, and the returns from the use of lime in such a system become less and may finally drop below that of land unlimed.

Amount of limestone to use.— From a consideration of all available field experiments it seems advisable to apply as much as two tons of ground limestone per acre as an initial application wherever the soil has become distinctly in need of lime. This may then be followed with one to two tons per acre once every rotation of three to six years. These amounts will be found very profitable applications, provided only that the limestone can be obtained at reasonable prices. In some elaborate pot-culture studies at the Pennsylvania Station it was found that satisfactory results were not obtained until an application was made of at least one ton per acre in excess of the theoretical amount needed to neutralize the determined acidity of the soil. The amount required to neutralize this acidity, as determined by the method they used, varied on different plats all the way from a few hundred pounds of limestone per acre to nearly two tons.

On many soils of New York State, especially the hill lands of the southern part, two tons of limestone per acre is not enough to give most satisfactory results and so three or even four tons will often be more profitable. In preparing land for alfalfa it should be remembered that this crop is unusual in its requirements for lime and that for best results enough should be used to insure the crop an abundance of that material during the next few years. Therefore three, four or even six tons of ground limestone per acre is often not an extravagant amount to use in such a case. For purposes of plant food alone alfalfa uses calcium and magnesium to the equivalent of as much as 100 pounds of limestone to each ton of cured hay.

Methods of applying.— By means of a special lime or fertilizer distributer is the most satisfactory way of getting limestone on the land. In this manner it can be spread with much less work and the same amount will effectively cover more ground than if scattered by hand or with a manure spreader. The fertilizer attachment of a grain drill has too small capacity for practical use in distributing limestone. It is best to apply the limestone to the rough ground after plowing, thus mixing it more thoroughly with the soil by disking and harrowing. It is in the line of good practice to apply any form of lime as long as practicable before seeding the first crop to be benefited by its application. Fall-plowed land furnishes an excellent opportunity for the application of limestone. Also summer-plowed land, to be seeded to grain in the fall and to clover or grass the following spring, furnishes a good opportunity for its application. In general it is much better to apply limestone in the summer and fall when the roads are good, the land firm, and work not so pressing, rather than in the spring when there is haste to get in the crops and conditions are not so good for hauling and applying.

Field tests for the need of limestone.— Soils which contain in their surface or near subsoil fragments of limestone are not in need of liming. Soils which turn blue litmus-paper pink* are nearly always in need of liming. In the eastern states soils with a light color, gray, grayish brown, or yellowish shade, are usually in need of liming. Whenever serious difficulty is experienced in growing good

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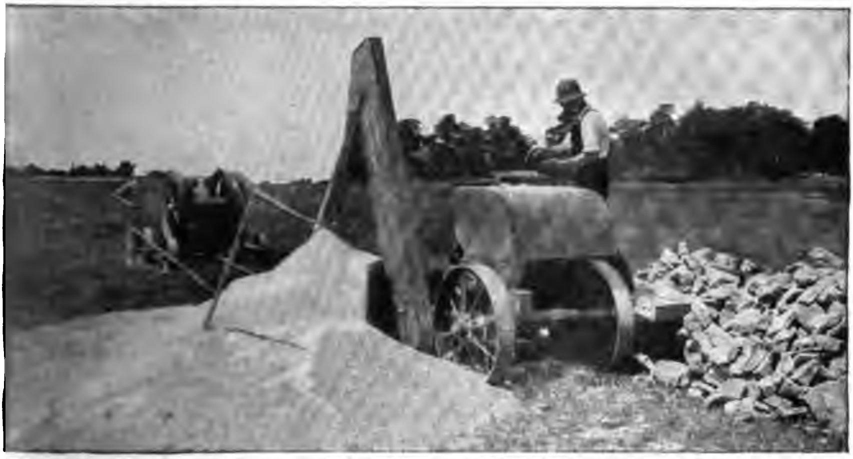
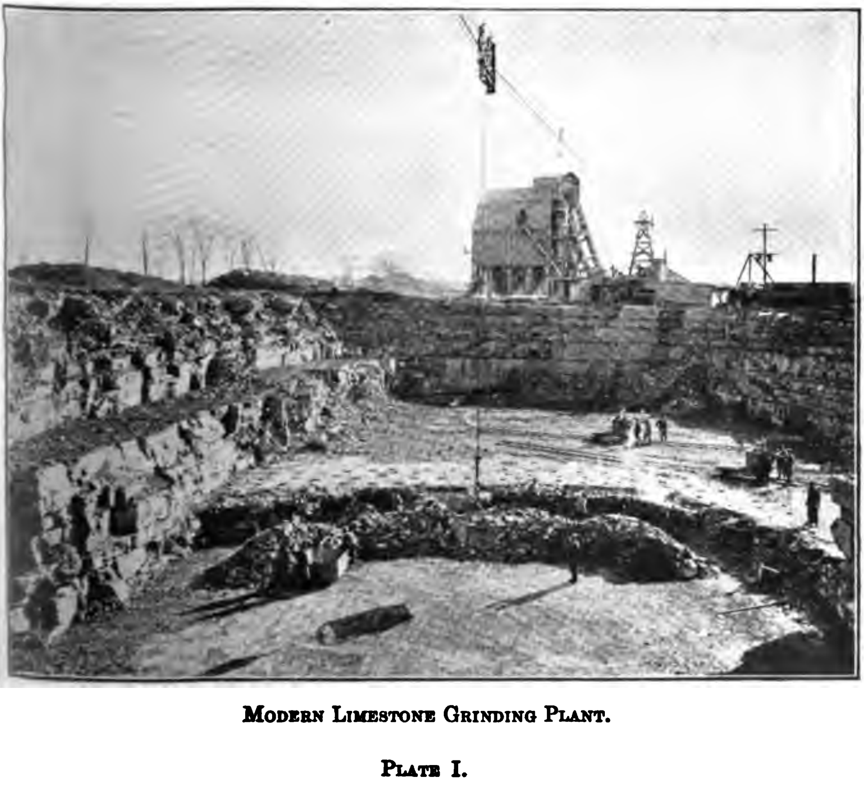
* It is not necessary to neutralize all the acidity of a soil to get results from liming, so after an application of lime has been made and some good results observed the soil may still be capable of turning blue litmus paper pink. But in such cases further benefit will usually follow the application of more lime.



Portable Limestone Grinder.



Modern Limestone Grinding Plant.

Plate I.

crops of common red clover or of alfalfa the need of liming is strongly indicated.

The litmus-paper test for soil acidity may be made as follows: Obtain a ball of wet soil about the size of the fist, break it open and insert a double thickness of blue litmus-paper (obtainable at any drug store). Press the ball firmly together and allow to stand as much as a half hour. If at the end of this time the paper in contact with the soil has distinctly changed to a pink color there is positive evidence of acidity and it may safely be assumed that benefit will follow liming. Of course it is best to make a number of tests in different parts of the field and the subsoil should be examined as well as the surface. The practice sometimes recommended of placing a piece of filter paper between the litmus paper and the soil renders the test of no value. The litmus must come in direct contact with the soil.

It is now nearly always possible to tell in advance whether or not a soil is in need of liming, without waiting for the slow and expensive method of trying out an application in the field. Besides, one year's trial may often fail to give conclusive results.

TECHNICAL SUBJECTS RELATING TO THE USE OF LIMESTONE.

Nature and use of burned lime.— Not only natural raw ground limestone but also freshly-burned and hydrated lime may be used for the purpose of supplying lime to soils deficient in lime carbonate. Freshly-burned and hydrated limes, however, rapidly change over to the carbonate form on being applied to the soil; that is, they very soon become of the same composition as ground limestone, a process familiar to every one in the changes that lime mortar undergoes on standing. If it were not for this fact neither of the caustic forms of lime could be used on the soil, for as long as they exist in the caustic condition they are liable to be injurious.

When pure calcium limestone ($CaCO_3$) is completely burned it loses 44 per ct. of its weight in the form of carbon dioxide gas (CO_2). The resulting product, which is calcium oxide or quicklime, contains just as much actual lime as the original limestone. It follows, then, that 56 pounds of pure quicklime are chemically equivalent to 100 pounds of pure limestone and will neutralize the same amount of acidity when applied to the soil. The above weight of quicklime slaked with just the right amount of water forms 74 pounds of hydrated lime, ($Ca(OH)_2$). When either of these compounds is exposed to the air for a long time it completely recovers the carbon dioxide (CO_2) lost in burning; thus " air-slaked " lime is of the same composition as pulverized limestone. If the limestone has a part of its calcium carbonate replaced by magnesium carbonate the latter undergoes changes similar to those outlined above. Limestone nearly always contains a certain amount of impurities, consisting chiefly of clay-like material. On burning, this material does not lose in weight like the rest of the stone, consequently burned lime will contain a higher percentage of impurities than the stone from which it is burned. Also, burned lime begins to take up weight again as soon as it is exposed to the air. The figures above, then, are changed somewhat in actual practice. For practical purposes it may be remembered that 1200 pounds of freshly-burned lime, 1500 pounds of hydrated lime and 2000 pounds of ground limestone all contain approximately the same amount of actual lime and are capable of neutralizing the same amount of acidity when applied to the soil, provided all forms are of good grade. Bulk lump lime offered to the agricultural trade at $4 to $5 per ton is not as good grade as that considered in these figures. In fact, it often contains the ashes from the coal used in burning, may contain some unburned core, and may be partly air-slaked. Ground limestone (or its equivalent " air-slaked lime "), freshly-burned lime and hydrated lime are the only three forms that can properly be called lime or that can be used for neutralizing the acidity of the soil. Marl is the same in composition as ground limestone and when it contains the same percentage of carbonates is of equal value. " Agricultural lime," " Land lime," etc., are only trade names given to any one of the three forms or a mixture of them.

Ground limestone vs. caustic lime.— Because of the caustic properties and finely powdered condition of burned lime the theory has often been advanced that it is better to use than the carbonate. There is no evidence, however, from any carefully conducted field test to show that this is ever the case. On the other hand, nine years of comparative trials in the field at the Ohio Agricultural Experiment Station, four years at the Tennessee Station, eleven years at the Maryland Station, elaborate experiments at the Pennsylvania Station and at the Rhode Island Station, together with much other evidence from this and from foreign countries, have shown that ground limestone gives at least as good results and often better than its equivalent in burned lime.[3] These experiments cover soils of various types, containing much and little organic matter; and they deal with small, medium and large applications of lime and with nearly all general farm crops. These experiments entirely discredit the theory that burned lime is any more effective for soil improvement than chemical equivalents of ground limestone. They show that ground limestone is likely to produce better results on the average than burned lime. Ground limestone is safer to use, since applied in almost any quantity at any time, it can have no injurious effect. (Excepting that it, as any material capable of neutralizing acidity, produces conditions more favorable to development of potato scab.) Instances are on record of positive injury to crops from the use of caustic lime. Ground limestone is so much more convenient to handle that this fact alone will usually lead the farmer to decide in its favor after he has once had experience in applying the two forms.

Limestone is a neutral material and does not exert a distinct alkaline reaction excepting when in contact with an acid. Even very weak acids easily decompose the limestone, setting free carbon dioxide and allowing the calcium or magnesium to combine with the acids, thus neutralizing them. There is no difficulty about the " availability " of ground limestone. If any acid condition is present in the soil it is easily neutralized by the limestone.

Magnesium limestones.— As previously explained, magnesium limestones are such as have a part of their calcium carbonate replaced by magnesium carbonate. In the highest magnesium limestones the two carbonates are found in a ratio equal to that of their molecular weights (100 : 84), 100 parts calcium carbonate to 84 parts magnesium carbonate. It may also be noted that in these relative quantities the two are capable of neutralizing the same amount of acidity, since a molecule of one is as good as a molecule of the other for that purpose. Eighty-four pounds of magnesium carbonate is then able to neutralize the same amount of soil acidity as 100 pounds of calcium carbonate. In order to compare two limestones carrying different proportions of the two carbonates it is well to compute the percentage of calcium carbonate that would be equal to the magnesium carbonate present and then add this computed percentage to the percentage of calcium carbonate. The results will be the *calcium carbonate equivalent.*

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[3] For further account of these experiments see Circular 27 of this Station.

Owing to the fact that caustic lime made from magnesium limestone more often produces injurious results when used on the soil than caustic lime from straight calcium stones, objection has grown up to the use of magnesium lime in any form. Also it has been proved that highly magnesian limestone when used in excessively large quantities (more than ten tons per acre at one application) may produce injury. But there is little if any evidence to indicate that magnesium limestone used in reasonable quantities or in amounts that anyone can afford to pay for will be any less beneficial than a like amount of calcium limestone. There is a large amount of evidence[4] to the effect that magnesium limestones are likely to produce slightly better results than non-magnesium limestones. Magnesium as well as calcium is one of the essential elements of plant food and there is evidence that on many soils additions of magnesium are needed for this purpose. The above mentioned book takes up this question as well. The New Jersey Station has recently published (Bulletin No. 267) the results of an extensive field test in which it was found that magnesium limestone gave somewhat better results than the non-magnesium. Bulletin 107 of the Tennessee Station indicates that magnesium limestones are more prompt in neutralizing acidity than non-magnesium. The Illinois Experiment Station has made use of 10 tons per acre of magnesium limestone on acid soils and obtained good results. In connection with the growing of alfalfa on the hill lands of southern New York, this Station has in the last two years used on two different farms four tons per acre of dolomitic limestone in comparison with a like amount of non-magnesium limestone. In each case the test was made on one-tenth-acre plats in duplicate. No difference was detected in the effect on the alfalfa crop of the two different kinds of limestone. Without lime in some form alfalfa could not be grown on these soils.

The evidence on the comparative value of magnesium and non-magnesium limestones for use on acid soils is such that there is no reason for any discrimination against the magnesium limestones.

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[4] Much of this evidence is summarized in a book, "Manures and Fertilizers," by H. J. Wheeler. New York: 1913.

They should be valued according to their calcium carbonate equivalent.

Fineness of ground limestone.— For practical use in the improvement of acid soils it is not important to have limestone ground extremely fine. There is plenty of evidence to warrant the conclusion that if limestone is ground fine enough so that the total passes a sieve with ten meshes to the linear inch and contains *all the fine material* produced in grinding it is as fine as need be for practical use, where the material is applied not oftener than once in a rotation of at least three years.

Under natural soil conditions limestone is much more soluble than most other soil constituents and is easily leached away. The easy solubility of this material is illustrated by the fact that the carbonates in many feet of limestone have often been leached away to form one foot of soil, which is made up mainly of the impurities contained in the lime rock. Also the caves and sink-holes found in limestone regions are due to the dissolving away of the rock by underground waters. The deposits of marl so frequently found in this State represent lime carbonate dissolved out of the surrounding lands. In an even more forceful way the solubility of limestone is illustrated by the large quantities of it contained in spring and well waters, it being the material which makes such water hard and which is deposited as a crust in kettles and boilers when the water is evaporated. More than this, the conditions found in an acid soil are about the most favorable of any in nature for the easy solubility of limestone.

When limestone is ground to pass a 10-mesh sieve from ⅖ to ⅔ of the product will pass a 40-mesh, depending somewhat upon the nature of the stone and upon the kind of machinery used. The entire product, then, is about as fine as representative samples of "finely ground" bonemeal. A mechanical analysis of these materials has been found in our laboratory to be as follows:

FINENESS OF 10-MESH LIMESTONE.

	Passing 10-mesh	Passing 20-mesh	Passing 40-mesh
Sample 1	100%	94%	62%
" 2	100	92	72
" 3	100	67	42
" 4	100	72	44
" 5	100	69	49
" 6	100	82	56
" 7	100	90	66

FINENESS OF 10-MESH LIMESTONE.—*Concluded.*

	Passing 10-mesh	Passing 20-mesh	Passing 40-mesh
Sample 8	100%	91%	63%
" 9	100	82	62
" 10	100	93	67
" 11	100	85	56
" 12	100	86	62
" 13	100	91	67
" 14	100	80	55
" 15	100	75	50

FINENESS OF GROUND BONE MEAL.

	Passing 10-mesh	Passing 20-mesh	Passing 40-mesh
Sample 1	96%	82%	65%
" 2	100	76	58
" 3	94	91	54

Fineness in bonemeal is more important than in ground limestone; for under soil conditions limestone ($CaCO_3$) is more soluble than bonemeal ($Ca_3(PO_4)_2$), is used in quantities ten to twenty times as great per acre, and costs about one-tenth as much per ton. Yet bonemeal of the above fineness is everywhere on the market and, excepting for its cost, is a favorite form of phosphorus fertilizer.

Some results from the Ohio Experiment Station bear directly on this subject. Different forms of lime and different amounts have been tried out in a rotation of corn, oats and hay (clover and timothy), the lime being applied once in the three years; manure is also used in the rotation at the rate of eight tons per acre. The following table gives the average value of increase for a three-year period due to both lime and manure. The five-year average is the first data published and the nine-year the last. The results from 500 and 2000 pounds per acre of burned lime are given to show that the comparison of different forms is based on quantities smaller than give maximum results on the soil in question.

VALUE OF AVERAGE CROP INCREASE PER ACRE FOR 3-YEAR PERIOD.

	(Ohio Station)	Average of 5 years	Average of 9 years
Freshly-burned lime	500 lbs. per acre	$9.65	$19.02
" " "	1000 " "	11.65	20.07
" " "	2000 " "	14.70	23.41
Ground limestone	1780 " " (10-mesh)	12.96	21.05
Air-slaked lime	1780 " "	11.77	22.57
Hydrated lime	1320 " "	11.82	20.75

The ground limestone was of such fineness that the total passed only a 10-mesh sieve, yet it has given fully as good results as chemical equivalents of burned lime, air-slaked lime or hydrated lime, any of which is an impalpable powder.

The Tennessee Station (Bulletin No. 97) compared burned lime with ground limestone for a period of four years on a variety of crops and found the limestone to give somewhat better results. The ground limestone was of such fineness that 19 per ct. did not pass a 20-mesh sieve. The burned lime was slaked and so reduced to a powder.

Rhode Island Station Bulletin No. 145 reports experiments showing that ground limestone was fully as effective as air-slaked lime, even for immediate results. The fineness of the limestone is not given.

Artificial (precipitated) calcium carbonate has been compared with " Limestone meal " and the latter found to give fully as good results, even for the first crop.[5]

In a comparison of crushed marble of different degrees of fineness it has been found that material passing a one-millimeter (20-mesh) sieve but coarser than a ½ millimeter (40-mesh) gave practically as good results as that finer than ½ millimeter, even for the first crop.[6]

In some lime and fertilizer experiments in connection with the growing of alfalfa on the hill lands of southern New York during the past three years, the authors have compared, along with other treatments, the following, each treatment being applied to duplicate one-tenth-acre plats:

Ground limestone 2 tons per acre	Basic slag 500 lbs.	per	acre
Hydrated lime equivalent to 2 tons G. L. per acre	"	"	"
Ground limestone 4 tons per acre	"	"	"
Hydrated lime equivalent to 4 tons G. L. per acre	"	"	"

The limestone has been approximately 10-mesh and has cost $1 to $1.50 per ton f.o.b. cars at shipping point, while we have paid $8 to $10 per ton for the hydrated lime at shipping points to insure getting the very best grade for comparison. This experiment has been tried in Chautauqua County, Schuyler County, Tioga County and Ostego County. In three of the cases the liming was done only a few weeks previous to seeding the alfalfa. In each of the four experiments a good stand of alfalfa was secured on these four plats, although on one field the alfalfa was later badly winter killed.

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[5] Experiment Station Record, 21:624.

[6] Rep't Penn. State College, 1900.

In no case was there any noticeable difference between the use of the ground limestone and the hydrated lime. Without lime in some form a stand of alfalfa could not be secured. There is a strong indication that four tons of limestone or its equivalent is not enough to give maximum results on any of these fields.

On the ordinary farm it is scarcely practicable nor advisable to attempt to go over all the cultivated land with an application of limestone more frequently than once in four to eight years. Besides, an ordinary system of crop rotation lends itself to the practice of liming only about once in three to six years; unless, of course, the material is applied as a top dressing, which is not so effective as mixing it with the soil. Especially does this apply to alfalfa growing. The problem, then, is not what is the minimum amount of limestone and maximum fineness for greatest net profit the first year, but rather what quantity and fineness will give the greatest net return over a period of at least three years. If enough 10-mesh limestone is used to last for that length of time it will, without question, give fully as good results the first year as a somewhat smaller amount of extremely fine material.

Increased fineness means increased cost of production. Also limestone ground as fine as dust can hardly be handled in bulk and must be sold in sacks, which adds as much as one dollar per ton to the cost. Ten-mesh limestone, which is about the consistency of bonemeal, can be readily used in bulk.

In view of all the above facts, therefore, it seems entirely unnecessary to urge that limestone be ground any finer than that the entire product pass a 10-mesh sieve and contain all the fine material produced in grinding.

Nature of soil acidity.— In natural soil processes acids are constantly being formed incidental to the decay of organic matter. These acids consist of carbonic acid, various organic acids and strong nitric acid (HNO_3). All have ability to combine with and remove from action the bases present in the soil. The formation of organic acids is familiar to everyone in the souring of milk, in the production of sauerkraut, in the fermenting of silage, and in the manufacture of wine and vinegar from fruit juices. Nitric acid is formed from the nitrogen of organic matter by the process of nitrification. In the production of almost any ordinary crop as much as 100 pounds of nitrogen per acre is converted into nitric acid. Under favorable conditions 200 pounds or more of nitrogen per acre are commonly transformed into nitric acid. One hundred pounds of nitrogen forms 450 pounds of nitric acid which is capable of using up 357 pounds of calcium carbonate. The carbonic acid and organic acids produced at the same time would be capable of using up a much larger quantity of limestone than this. If carbonates are not present to combine with these acids they attack the silicate compounds of the soil and extract from them their basic constituents, such as calcium, magnesium, sodium and potassium Acids are added to the soil to some extent by the use of many commercial fertilizers. When 500 pounds of acid phosphate is added to the soil enough acid is introduced to use up about 200 pounds of limestone. By the use of ammonium sulphate $(NH_4)_2SO_4$ a small amount of sulphuric acid (H_2SO_4) is formed, as the plants use up the ammonia and leave the free sulphuric acid behind. Carefully conducted field tests show that plats treated with ammonium sulphate become acid sooner than plats alongside treated with a similar amount of nitrogen in nitrate of soda or dried blood. When free sulphur is added to the soil, as in the dusting of plants for fungus diseases, it is soon oxidized to sulphuric acid and relatively large quantities of acid may be formed in this way.

It is not correct to say that acid soils are due to an accumulation of acids, such as described above, for hardly an appreciable amount of acid is ever present in the free state in any soil. But the acids remove the bases from the soil, first the carbonates and then the basic constituents of the silicates; and when this process has gone on long enough the soil becomes deficient in basic materials. It is then potentially acid; that is, it behaves as an acid in the presence of basic materials or a compound like limestone which readily parts with its basic constituents in the presence of even very weak acids.

LIMESTONES OF NEW YORK, WITH REFERENCE TO THEIR AGRICULTURAL USE.*

R. C. COLLISON AND J. F. BARKER.

SUMMARY.

The first part of the bulletin gives a brief description of each of the forty-nine limestone formations found within the State of New York; there is mentioned the stratigraphic position, general locality, approximate thickness, adaptability to agricultural use and outstanding characteristics of each formation.

The more important formations are next taken up separately for more detailed descriptions, together with the results of analyses of a varying number of samples of each.

A limestone map accompanies the bulletin, showing the area of outcrop of each of the more important formations or group of formations. (Map in pocket at back of report.)

Two stratigraphical columns are given showing diagrammatically cross sections of the hard rock geology for both the eastern and western halves of the State. In this way the geological relations and comparative age of the different limestones are shown graphically. Finally the subject of types of limestones and origin of limestones are briefly discussed.

INTRODUCTORY NOTE.

The rapidly increasing use of limestone for purpose of soil improvement has developed an interest regarding the limestone supplies of the State among a far larger number of people than ever before. Although much work has previously been done on the geology of New York limestones, this is scattered about in miscellaneous reports so that a publication giving a general idea of the subject has scarcely been available to the public. Also previous limestone studies have not been made with any special reference to the agricultural use of the stone. This bulletin is based upon miscellaneous reports regarding New York limestones, supplemented by field work carried on by the Department of Agronomy of the Station during two summers and by the analyses of numerous samples collected in the course of our field studies. Only a general outline of the subject is so far accomplished, and much more field work will have to be done before the limestones can be discussed as fully as their agricultural importance deserves.

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* A reprint of Technical Bulletin No. 47, December, 1915.

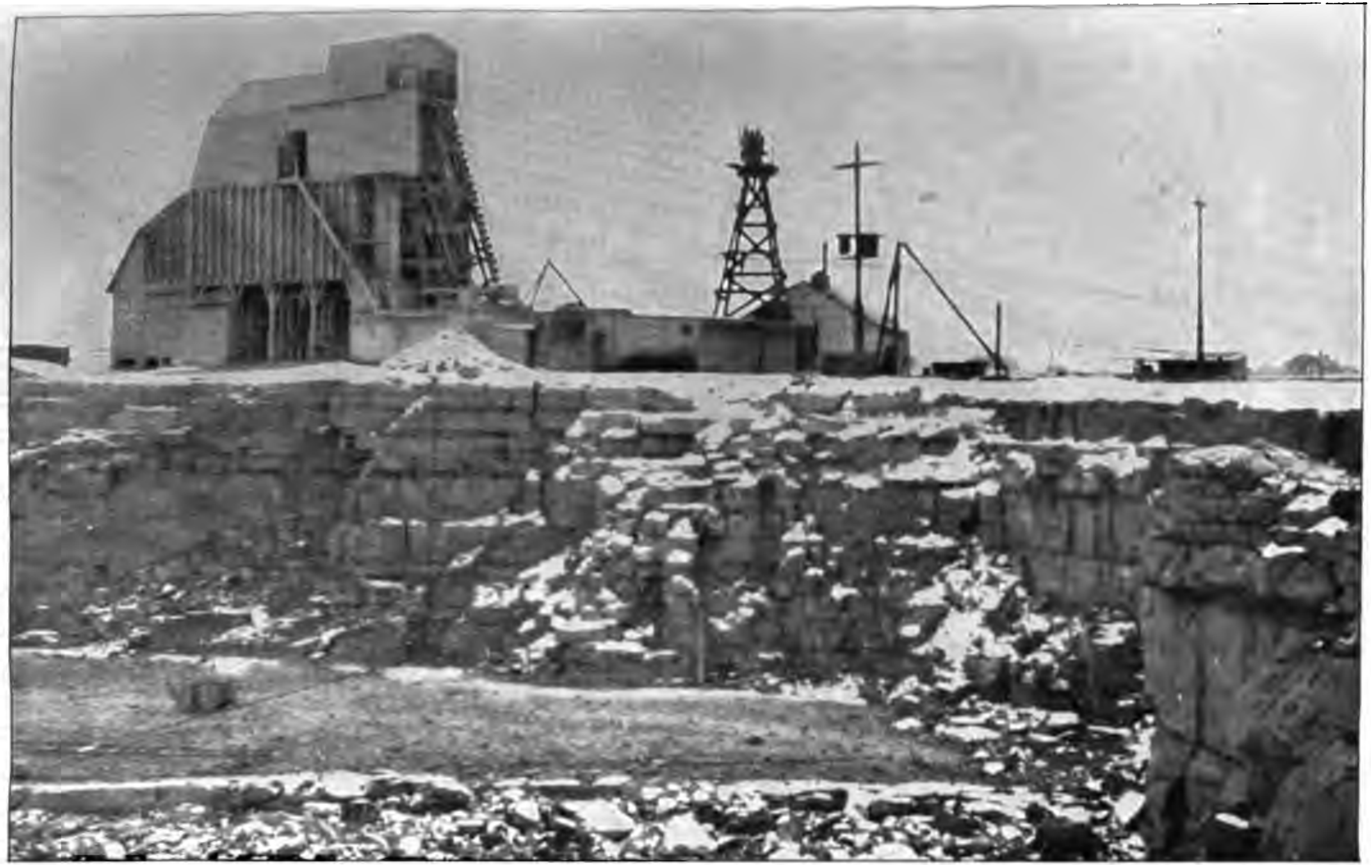

Plate II — Crushing and Grinding Plant at Quarry in Onondaga Limestone near Auburn, N. Y., Showing Modern Quarry Operations.

UNIV. OF MICH.

In the preparation of the limestone map the authors have had the valuable assistance of Prof. George H. Chadwick of the University of Rochester and they wish at this time to acknowledge their indebtedness for this help and for other valuable suggestions made by him.

DESCRIPTION OF LIMESTONE FORMATIONS.

Within the borders of the State of New York are found at least forty-nine distinct limestones worthy of separate nomenclature. They represent many types and all grades of purity and vary greatly in industrial importance. For convenience of reference they are all mentioned in Table I, where a brief description of each is given. They are numbered in the order of their occurrence in the geologic columns, from the most recent to the oldest formation. The more important formations are taken up one at a time for a somewhat detailed description, the same numeral order being followed.

TULLY LIMESTONE. (3)

This formation runs in a narrow outcrop through the west central part of the State. Its type locality is at Tully in southern Onondaga County. It reaches a maximum thickness of about 30 feet. In character it is a fine-grained blue to black stone, very hard when fresh but on long exposure assumes a light gray color and tends to

COMPOSITION OF TULLY LIMESTONE.*

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.†	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
52	Dresden, Yates Co.	92.44	90.00	2.06	92.06	4.45	3.49
53		91.84	89.68	1.82	91.50	4.98	3.52
100	Hayt's Corners, Seneca Co.	93.20	90.20	2.53	92.73	5.50	1.77
101		93.52	90.00	2.97	92.97	5.06	1.97
102		93.20	89.80	2.87	92.67	5.42	1.91
165	South end of Skaneateles Lake	89.6	87.9	1.40	89.3	8.50	2.20
166	Borodino	94.8	93.3	1.30	94.6	3.00	2.40
167		91.5	90.2	1.10	91.3	6.00	2.70
168		93.4	91.3	1.80	93.1	4.74	2.16

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* The greater number of the analyses in this and succeeding tables were made by R. F. Keeler, assistant chemist in this Department.

† By "carbonate equivalent" is meant the figure obtained by calculating all the carbon dioxide to calcium carbonate.

TABLE I. BRIEF DESCRIPTION OF THE LIMESTONE FORMATIONS OF NEW YORK.

No.	Formation.	Stratigraphic position.	Locality.	Thickness. *Feet*	Adaptability to agricultural use.	Description.
1	Parish l. s.	In upper Cashaqua Shale.	Keuka Lake region, west.	2½–5	Poor	Impure, with greenish or reddish concretionary nodules. Shaly partings. Not used.
2	Genundewa l. s.	In Genesee shale	Canandaigua Lake, westward.	2–8	Poor	Thin, compact, concretionary, with shaly partings. Some places made up entirely of shells (Pteropod Ooze) bituminous, hence dark in color. One layer used locally for foundations.
3	Tully l. s.	Below Genesee shale	Canandaigua Lake to northern Chenango Co.	30	Excellent	Fine grained, dark color. Used for road work and Portland cement. Very little used at present.
4	Menteth l. s.	In Moscow shale, 75′ above Tichenor.	Canandaigua Lake, west.	1	Poor	Thin, compact, fossils replaced by silica making many perfect specimens. Not used.
5	Tichenor l. s. (Encrinal).	In Hamilton beds	Canandaigua Lake, west.	1½–3	Fair	A crinoidal limestone. A single layer of compact hard durable limestone. Shaly in places. Fauna abundant. Too local and thin for use.

TABLE I. BRIEF DESCRIPTION OF THE LIMESTONE FORMATIONS OF NEW YORK (*continued*).

No.	Formation.	Stratigraphic position.	Locality.	Thickness.	Adaptability to agricultural use.	Description.
6	Centerfield l. s.	In Canandaigua shale (Ludlowville) near bottom.	Canandaigua Lake region, west.	*Feet* Thin	Fair	Fairly compact. Coral in structure. Not a satisfactory building stone. Too thin for use.
7	Stafford l. s.	In Marcellus beds	Western New York to Buffalo.	4–15	Good	Blue gray, thick layers, resembling Onondaga. Chert nodules. As far east as Phelps (4 inches thick). Usually too thin for use agriculturally.
8	Cherry Valley (agoniatites) l. s.	In Marcellus shale 15′ above base.	Western New York Otsego Co. west.	3±	Poor	Impure, contains numerous cephalapod remains. Too soft for building. Too impure for lime.
9	Onondaga l. s.	Between Marcellus and Oriskany.	Buffalo through central N. Y. and south to Orange Co.	250	Excellent	Gray and blue compact l. s. Chert nodules characterise portions of formation. A good building stone, also used extensively for agricultural purposes. A formation of wide extent.
10	Glenerie l. s.	Eastern equivalent of Oriskany s. s.	Greene County and south.	Several	Poor	In Greene County is a chert. In Rondout region is a limestone. Not used.

11	Port Ewen l. s.	Below Oriskany	Ulster County	150±	Only fair	From massive to shaly. Dark gray concretionary in places along bedding planes. By weathering develops rows of small pits 6–18″ diameter. Upper layers weather to buff color. Not used.
12	Port Jervis l. s.	Equivalent of Port Ewen further south.	Orange County and New Jersey.	......	Poor	Resembles Port Ewen. Fauna different. Shaly, impure, of little importance.
13	Becraft l. s.	Upper limestone member of Helderbergian group.	Eastern New York, Dutchess and adjoining counties.	60	Excellent	Coarsely crystalline, light in color. Approaches a pure shell rock. Of resistant character and massive bedding. A stone of high purity. At present little used agriculturally.
14	New Scotland l. s.	Succeeds the Coeymans in Helderbergian group.	Eastern New York, Schoharie, Greene and Orange counties.	100	Too impure for extensive use.	Shaly limestone, disintegrates readily. Dark gray to reddish in color, developing numerous iron stains.
15	Kalkberg l. s.	Above Coeymans	Greene County	......	Poor	Shaly, seams of black chert. Rich in brachiopod shells which are silicified and weather out in perfect form. Not used.
16	Coeymans l. s.	One of main members of Helderbergian group.	Eastern and east central N. Y.	50	Very good	Coarse, semi-crystalline limestone, largely composed of shells. Compact, hard and dark in color. Beds massive. Used for Portland cement and quite extensively for agricultural lime.

TABLE I. BRIEF DESCRIPTION OF THE LIMESTONE FORMATIONS OF NEW YORK (*continued*).

No.	Formation.	Stratigraphic position.	Locality.	Thickness.	Adaptability to agricultural use.	Description.
17	Manlius l. s.	Below the Helderbergian group.	Western New York outcrop narrow.	*Feet* 50	Good but somewhat variable.	A dark, very fine grained, often impure limestone. Breaks or splits with a diamond fracture. Used agriculturally to a great extent.
18	Rondout waterlime...	Cayugan waterlime group:	West central to eastern N. Y.	50	Too impure for extended use.	Transition between the Manlius and the Cobleskill and Bertie. An impure magnesium stone, gray in color interstratified with shaly layers. Road use and rough building.
19	Cobleskill dolomite...	A Cayugan waterlime	Follows Rondout closely.	20±	Good..........	The " Bullhead " stone of the Buffalo region. A dark-colored dolomite in thin layers. Becomes porous on exposure and assumes a buff or brown color. A number of companies grind the stone for agricultural use.
20	Bertie waterlime.....	Belongs in Salina beds. Overlies the gypsum.	From western New York to east central, giving place to Rosendale in eastern N. Y.	50±	Too impure for extended use.	Gray to buff color, thin bedded with large salt cavities. Used for cement.

21	Rosendale waterlime..	Replaces Bertie in eastern New York.	Eastern New York.	22±	Too impure for agricultural use.	Closely related to the Bertie. Type locality is at Rosendale in Ulster County. A good cement rock.
22	Decker Ferry l. s.....	Equivalent of Bertie.	Eastern New York limited extent.	......	Outcrop local but a fair stone.	Found in Orange and Ulster counties. Closely associated with Cobleskill. Brown in color, massive layers, shale partings. Magnesium in character. Used agriculturally in a limited way.
23	Wilbur limestone.....	Below Rosendale cement beds.	Schoharie region...	3–8	Only fair.......	Fossiliferous lime sand-rock. Similar to Cobleskill. Local phase of lower Rosendale cement beds.
24	Bossardville l. s......	Just below Decker Ferry.	Orange County....	12±	Outcrops too limited.	From New Jersey extends over New York line. Not used.
25	Fiddler's Green limestone.	In Salina beds......	Syracuse region....	40±	Poor...........	Thin-bedded, dolomitic. Surface cut into rhomboidal figures by narrow grooves formed in weathering. Fossiliferous. Not used.
26	Vermicular l. s......	In Salina beds below Fiddler's Green.	Syracuse region...	50±	Poor..........	Porous or cellular, resembling cellular lava, due to solution of probable celestite. Crumbles easily on weathering. Beds alternate with shale and are too impure for use.

TABLE I. BRIEF DESCRIPTION OF THE LIMESTONE FORMATIONS OF NEW YORK (*continued*).

No.	Formation	Stratigraphic position.	Locality.	Thickness.	Adaptability to agricultural use.	Description.
				Feet		
27 & 28	Guelph dolomite.....	Members of Niagara group.	Western New York.	15	Excellent.....	Two formations closely related. So-called Niagara l. s. Dark to black dolomite, resistant, has many cavities filled with calcite and dolomite crystals. Its excellent quality justifies more extended use.
	Lockport dolomite...	....	....	250±	....	
29	Irondequoit l. s......	Included in Clinton beds.	Western New York.	Several	Very limited. Too thin and impure.	Layers uneven with shale partings, semi-crystalline. Sometimes contains considerable iron pyrite. Part of so-called "Clinton Limestone."
30	Wolcott l. s.........	Part of Clinton beds.	Western New York.	14	Very good......	So-called "Clinton Limestone." Crystalline in texture, contains many associated minerals used as a firestone, also to some extent agriculturally.
31	Trenton l. s.........	Upper l. s. member of Mohawkian.	Widely distributed through northern and northeastern New York.	475±	Excellent.......	Dark, thin-bedded, compact limestone with many fossil shells. Burned for lime and ground extensively for agricultural use.

32	Glens Falls l. s.......	Above Black River beds. Basal Trenton	Saratoga and Glens Falls region.	50±	Excellent.......	Thin bedded, numerous fossils. Usually high in $CaCO_3$. Could be more greatly utilized.
33	Amsterdam l. s......	Upper member of Black River beds.	Somewhat similar to Glens Falls...	50±	Excellent.........	A very pure, high calcium stone of gray to blue color. Crystalline. So-called "Black Marble" of Glens Falls region. Thin-bedded and fossiliferous. Very little utilized agriculturally at present.
34	Watertown l. s.......	Black River beds....	Northern New York 1000 Islands region.	With Leray 18	Good..........	Dark blue gray to black with indistinct bedding planes. Very hard. Some layers have considerable organic matter. Contains so-called "7 foot" tier.
35	Leray l. s...........	Black River beds. Caps the Lowville.	Same as Watertown	With Watertown 18	Considerable chert lowers its value.	Dark gray to black or dove colored. Heavy bedded with much chert. Weathers into small fragments.
36	Lowville l. s.........	Lower member of Black River beds.	Northern and northeastern New York	60±	Excellent.......	So-called "Birdseye" stone. Very fine grained of dove color filled with branching calcite tubes. Brittle. Used extensively for agricultural lime.

TABLE I. BRIEF DESCRIPTION OF THE LIMESTONE FORMATIONS OF NEW YORK *(continued)*.

No.	Formation.	Stratigraphic position.	Locality.	Thickness.	Adaptability to agricultural use.	Description.
37	Chazy l. s.	Upper Canadian member.	Champlain region.	*Feet* 890	Very good......	Predominantly a calcium stone. Dove colored to black, compact. Upper and lower portions somewhat impure. Usually fine grained and more or less massively bedded. Used in a limited way agriculturally.
38	Pamelia l. s.	Stones River beds...	North Central New York 1000 Islands region.	150	Too impure for extended use.	A rather impure limestone to dolomite, sandy in character. Usually a gray to blue gray limestone shading off into a calcareous sandstone. Too impure for extended use.
39	Beekmantown l. s.	Most extensive member of Canadian group.	Widely distributed. Northern, eastern and northeastern New York	1800	Too impure for extended use.	A great mass of impure limestones and calcareous sandstones of somewhat limited industrial importance. Used however to some extent.
40	Bald Hill l. s.	Northern equivalent of Wappinger.	Saratoga region...	100±	Some local use for burning.	Light blue gray to dark gray. Fine grained and massive but often sandy. Dolomitic, sometimes resembling Little Falls dolomite.

41	Tribes Hill l. s.	Below Beekmantown.	Mohawk Valley and 1000 Island region	168	Good	Sometimes called "Fucoidal" l. s. Dark blue, fine grained, somewhat arenaceous. Resembles Lowville. Not utilized to any extent.
42	Little Falls Dolomite.	Upper member of Saratogan group.	Region of Little Falls, New York, and East.	400	A fair stone in places.	Uniformly blue gray, fine grained, crystalline dolomitic limestone. Bedding distinct. Numerous cavities with quartz, dolomite and calcite crystals. Very little used at present.
43	Hoyt l. s.	Below Little Falls.	Eastern New York Saratoga region.	100	Only a fair stone.	Alternating layers of calcium stone and dolomite. Dark to black in color. Very local in extent.
44	Neeleytown l. s.	Orange Co. equivalent of Hoyt probably.	Orange Co. south.	Less than 50	Excellent	Area small, stone light blue granular. Upper layers sometimes brecciated. Massive with irregular bedding. Fossils scarce. Chert nodules abundant. A magnesium stone. Beginning to be utilized. Analyses of two samples from near Neeleytown gave an average of Calcium carbonate equivalent........100.4 % Calcium carbonate... 57.75 Magnesium carbonate 35.95 Total carbonates.... 93.70 Insoluble matter..... 5.78 Fe_2O_3, Al_2O_3, H_2O+. .52 by difference

TABLE I. BRIEF DESCRIPTION OF THE LIMESTONE FORMATIONS OF NEW YORK (*concluded*).

No.	Formation.	Stratigraphic position.	Locality.	Thickness.	Adaptability to agricultural use.	Description.
				Feet		
45	Theresa Dolomite....	Above Potsdam sandstone.	Northern New York 1000 Island region.	200+	Usually too impure for extensive use.	A transition between Potsdam sandstone and Little Falls dolomite, therefore impure and sandy. Dolomitic in character, with thin beds. Considerable quartz in rock cavities. Not utilized agriculturally.
46	Wappinger and Fishkill l. s............	Of middle and lower Cambrian age.	Southeastern New York	1000+	Quite variable from very good to very poor.	Crystalline or subcrystalline metamorphic limestones. Mostly dolomitic. Exceedingly variable both in composition and texture. Used to considerable extent.
47	Stissing l. s..........	Above Georgian quartzite.	Dutchess County..	......	Rather impure for agricultural use.	A limestone of limited extent, the only representative of Acadian group in New York. Lower Cambrian fossils. Upper part arenaceous to pure shale. Of little importance.

48	Inwood l. s.	Precambrian........	Southeastern New York.	200–800	Variable. Usually a very good stone.	A belt of metamorphic limestones, mostly dolomitic, coarsely crystalline, with many accessory minerals. Weathers in places into a fine dolomitic sand. Used to some extent.
49	Grenville & Franklin l. s.	Precambrian. Oldest limestone in existence.	Northern, northeastern New York and Orange Co.	Unknown	Variable. Many excellent samples are found in this formation.	Highly crystallized metamorphosed sediments. Considerable range of color and composition. Some of our purest limestones. Many accessory minerals present. Outcrops are usually small and widely separated. Used to some extent.

crumble into small fragments. The basal layer and a few of the top ones are somewhat shaly. Frequent joints divide the stone into large blocks which are often found detached along the ravines in the region where it outcrops. It is used for road work, Portland cement, and for agricultural purposes. It is distinctly a calcium stone. The composition of representative samples is given below.

ONONDAGA LIMESTONE. (9)

The Onondaga formation, sometimes called Corniferous, is commercially one of the most important in the State. Its outcrops are widely distributed, extending almost across the State, east and west, in a rather narrow band. The formation varies in thickness from very little to 250 feet in the Niagara region.

COMPOSITION OF ONONDAGA LIMESTONE.

Lab. No	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
12	**Oriskany Falls, Oneida Co.**	88.92	75.20	11.56	86.76	10.58	2.64
13		88.30	86.51	1.51	88.02	10.81	1.17
21*	**Richfield Springs, Otsego Co.**	90.08	89.75	......	......	8.72	....
22		92.30	84.49	4.01	88.50	6.10	5.40
82	**Cullen, Herkimer Co.**	90.32	88.85	1.24	90.09	8.16	1.75
83		91.70	89.47	1.88	91.35	7.46	1.19
88*	**Leroy, Genesee Co.**	90.52	89.28	1.05	90.33	8.24	1.43
106		91.76	88.53	2.72	91.25	7.16	1.59
107		91.40	89.58	1.53	91.11	6.58	2.31
108		92.76	88.95	3.21	92.16	6.22	1.62
109		94.84	92.30	2.14	94.44	4.20	1.36
118	**Auburn, Cayuga Co.**	89.12	85.45	3.10	88.55	9.24	2.21
119		90.20	84.83	4.50	89.33	9.60	1.07
120*		88.20	84.40	3.20	87.60	10.00	2.40
121		87.72	84.60	2.60	87.20	9.48	3.32
122		93.92	85.45	7.03	92.48	5.00	2.52
123		89.90	86.30	3.03	89.33	9.12	1.55
151	**Blakeslee**.........	81.6	80.7	.76	81.46	18.02	.52

*Ground limestone.

The lower portion of the formation is known as Onondaga gray limestone, which is of crystalline texture and very durable. Fossils are abundant in this portion, corals being in the majority. Weathering takes place along the vertical joint planes leaving deep fissures in the rock which sometimes extend 100 feet below the surface. Caves also occur, formed by process of solution.

Overlying this gray portion is a thick stratum of compact blue limestone with a large amount of scattered chert and hornstone masses, which injure the stone for building or burning. The upper part of this division is fairly free from chert but has some clay and is sometimes called "Seneca Limestone."

The lower crystalline portion is the most important building stone in the region of Syracuse. It has great strength and durability; has also been used for soda ash manufacture. At the present time it is utilized to a large extent agriculturally all along its line of outcrop.

It varies considerably in composition. Its type localities are in Onondaga County where in composition it is distinctly a calcium stone.

The preceding table shows the range of composition in various parts of the State.

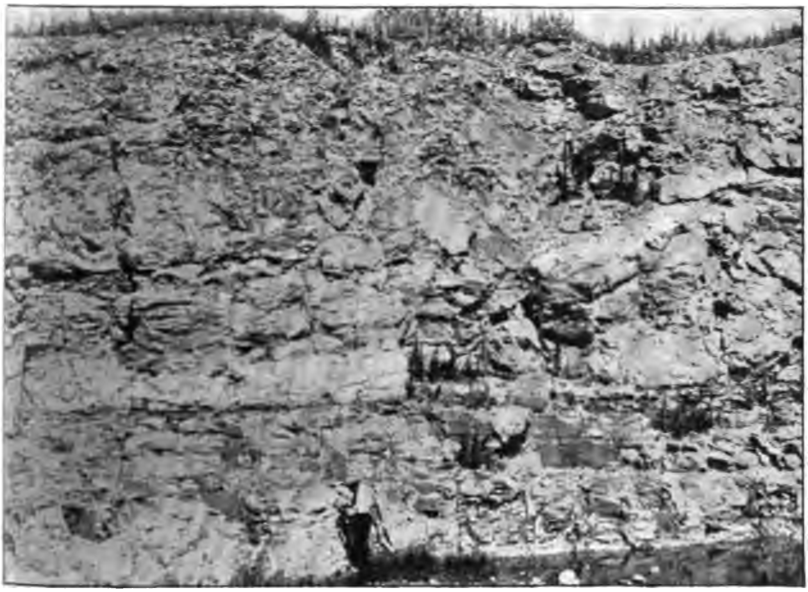
BECRAFT LIMESTONE. (13)

This limestone, sometimes called Upper Pentamerous, is found in eastern New York, especially in Dutchess and adjoining counties. In Greene County it reaches a thickness of 60 feet. Its type locality is at Becraft Mountain in Columbia County.

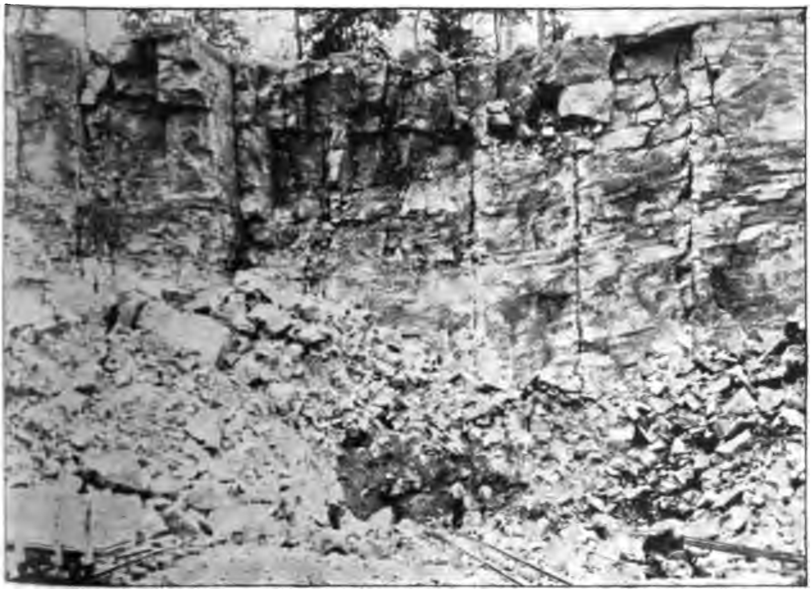
COMPOSITION OF BECRAFT LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
47	Kingston, Ulster Co.	95 60	95 60	0.84	96.44	2.50	1.06
	Becraft Mt., Columbia Co.	96.4	91.70	3.51	95.2	......	....
	Rondout..........	......	96.50	trace	......	......	....
	Willow, Ulster Co..	......	80.75	trace	......	......	....

The Becraft is a coarsely crystalline limestone, very densely packed with brachiopod shells, frequently approaching a pure shell rock.

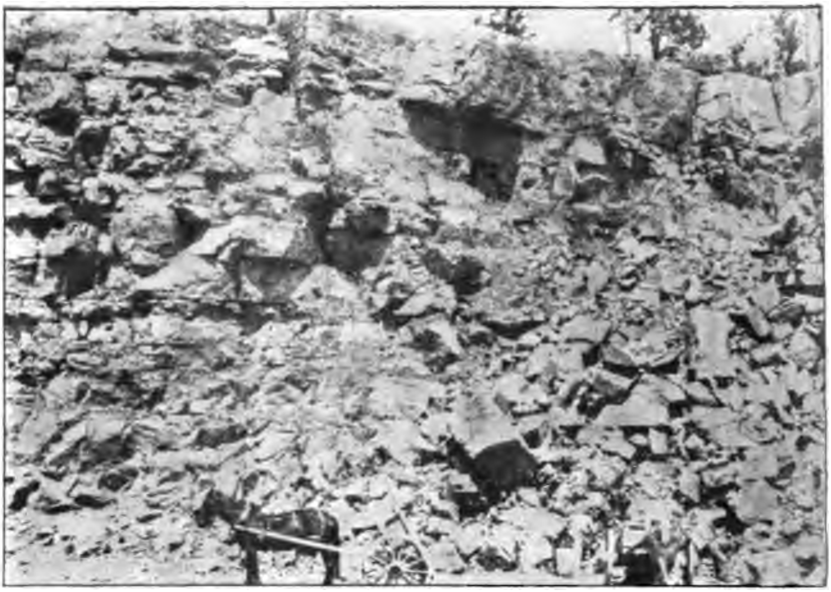


Tully Limestone. Almost Complete Section near Borodino, N. Y.

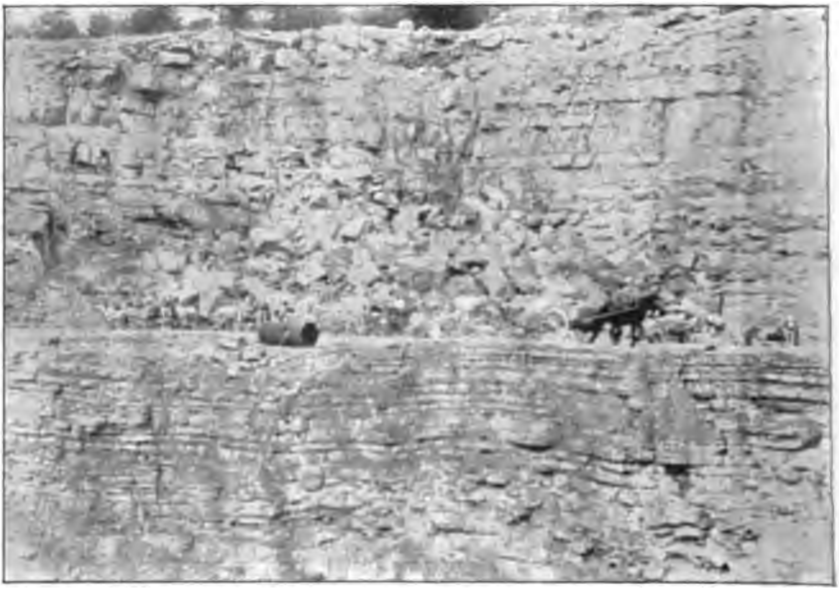


Coeymans and Manlius Limestones near South Bethlehem. Upper Third Coeymans. Lower Part Manlius.

PLATE III.



Manlius Limestone Capped by a Massive Layer of Onondaga, near Blakeslee, N. Y.



Typical Section of Manlius Limestone near Munnsville, N. Y.

PLATE IV.

It is massively bedded, compact and hard, and when fresh is dark gray in color, weathering to a cream or white. The stone is resistant and often projects above the surrounding landscape forming rock shelters. It is also cut by joint planes which on weathering become greatly widened into fissures. It is sometimes called shell marble and makes a fine building stone. It is made use of to only a limited extent agriculturally, although it is an excellent stone for this purpose. The Becraft is a high calcium stone usually of high purity, which is shown by the analyses given.

NEW SCOTLAND LIMESTONE. (14)

This is the limestone found in the New Scotland Beds of eastern New York. The whole formation reaches a thickness in Greene County of 100 feet. In character it is very shaly and weathers very easily, forming soil-covered slopes and clay soils. The disintegrated material usually contains a large number of more resistant fossils. The beds are thin, and dark gray to reddish in color, often sandy, and on weathering develop iron stains.

It is used locally but not as yet to any great extent as a source of lime. Its type locality is at New Scotland in Albany Co.

COEYMANS LIMESTONE. (16)

The Coeymans limestone, sometimes called Lower Pentamerous, is an important one in the eastern part of the State where in the Schoharie region it reaches a thickness of 80 feet, its type locality being at Coeymans in Albany County.

It is a rather coarse, semi-crystalline stone made up largely of coral and other fossil remains. It is compact and hard, of uniform grain and usually dark in color. The lower beds are generally somewhat massive, the upper ones thinner. Like the Becraft this stone is resistant and forms rock shelters and ledges. It varies considerably in texture from top to bottom, from shaly and argillaceous lime sand rock to compact stone below resembling the Manlius. It is quarried to some extent for Portland cement and in recent years for agricultural purposes.

COMPOSITIONS OF COEYMANS LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
156	South Bethlehem..	92.4	91.3	.93	92.23	5.7	2.07
	South Bethlehem..	87.04	79.06	6.65	85.71	......	....

MANLIUS LIMESTONE. (17)

This stone, sometimes called Tentaculite Limestone, rivals the Onondaga in commercial importance. With the exception of its western extension it closely follows the outcrops of the Onondaga from east to west. In Onondaga County it reaches a thickness not far from 80 feet. It takes its name from the type locality at Manlius in Onondaga County.

At the top of the formation is a four-foot layer of waterlime then four to five feet of pure blue calcium limestone known in the quarries as "Diamond Blue Rock." It develops many joints and fractures, thus coming from the quarries in small fragments.

Following the diamond blue comes four feet of argillaceous dolomite which makes good hydraulic cement. Then comes the main mass of blue, almost black, stone mixed with layers of lighter colored dolomitic stone.

The stone in general is very hard but brittle, splitting easily along the lines of deposition with a diamond fracture.

The rock is used very extensively for road work, ballast, concrete, soda ash, Portland cement and recently for agricultural purposes.

It contains relatively more magnesium carbonate than the Onondaga, this constituent sometimes running as high as 20 per ct. Calcium carbonate may run as high as 96 per ct.

COMPOSITION OF MANLIUS LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc., by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14	Munnsville,	95.44	94.75	trace	......	3.30	....
15	Madison Co.	92.08	92.08	trace	......	7.37	....
16*		94.44	94.14	trace	......	4.41	....
50*	Mellenville,	79.44	70.30	8.34	78.00	19.50	2.50
51	Columbia Co.	86.90	81.08	4.90	85.98	11.80	2.22
60†	South Bethlehem,	82.68	75.20	8.20	81.50	11.74	6.76
61	Albany Co.	87.56	83.07	3.78	86.85	8.46	4.69
62		92.48	89.40	2.80	92.00	5.30	2.70
68*	Syracuse,	87.28	69.47	17.72	84.49	12.01	3.50
69	Onondaga Co.	88.92	71.25	17.52	86.14	10.32	3.54
70		93.76	77.71	15.44	91.23	6.50	2.27
71		94.56	82.30	12.12	92.63	5.72	1.65
72		89.84	76.04	13.92	87.67	7.78	4.55
73		87.44	67.13	20.40	84.24	13.26	2.50
124		98.16	95.63	2.13	97.76	1.50	0.74
125		94.44	87.40	5.93	93.33	4.88	1.79

COMPOSITION OF MANLIUS LIMESTONE (*continued*).

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc., by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
126‡	Syracuse region (*continued*)	91.64	89.30	1.97	91.27	6.10	2.63
127*		92.90	89.90	2.53	92.43	4.28	3.29
128*		93.20	90.30	2.44	92.74	4.58	2.68
74	Blakeslee, Madison Co.	94.70	94 08	0.52	94.60	0.84	4.56
75		95.10	91.55	1.36	92.91	3.50	3.59
76*		93.16	91.04	1.92	92:83	6.08	1.09
77		93.60	91.14	2.76	93.20	5.64	1.16
78		97.04	95.43	1.36	96.79	1.10	2.11
129*		95.00	93.90	0.93	94.83	4.02	1.15
130*		94.25	93.25	0.84	94.09	4.34	1.57
27*	Sharon Springs, Schoharie Co.	97.08	96.26	0.69	96.95	2.34	0.71
28		92.44	91.36	0.91	92.27	5.87	1.86
29		95.12	94.04	0.91	94.95	3.70	1.35
46	Kingston, Ulster Co.	95.76	93.48	1.92	95.40	2.30	2.30
169	Union Springs,	76.4	70.30	5.10	75.4	21.4	3.20
170	Union Springs....	76.8	69.90	5.80	75.7	21.64	2.66
157	South Bethlehem..	91.5	86.50	4.20	90.70	7.80	1.50
150	Blakeslee.........	97.1	97.60	......	......	1.14	....
152	Munnsville.......	90.6	77.60	10.9	88.5	9.62	1.88
153	Munnsville.......	96.2	93.75	2.10	95.85	3.46	.69

* Ground limestone. † Screenings. ‡ Dust.

RONDOUT WATERLIME. (18)

The Rondout follows the Manlius rather closely in outcrop. In Onondaga County it reaches a thickness of 60 feet, while in the Schoharie region it is over 40 feet thick. It marks a transition stage between the gray-colored dolomites below, the Bertie and Cobleskill, and the purer Manlius stone above, with less magnesium. The formation consists of gray dolomite interstratified with shaly dolomites to argillaceous shales. Some of the layers near the base are rich in celestite crystals which on weathering out give the rock a vermicular texture. In the eastern part of the State it is a lime sandrock with remarkable sand crack structure in many places. It is used a great deal for roads and rough buildings, but not to any extent for agricultural purposes. It is altogether inferior to the Manlius. The type locality is at Rondout in Dutchess County.

COMPOSITION OF RONDOUT WATERLIME.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
148	Blakeslee.........	93.4	87.4	5.05	92.45	5.20	2.35
149	Blakeslee.........	84.8	57.9	22.7	80.6	15.34	4.06

COBLESKILL DOLOMITE. (19)

This stone, sometimes called the Coralline limestone, follows closely the Manlius and Rondout in outcrops. In Erie County it is 15 feet thick, in the Schoharie region 20 feet. Its type locality is along Cobleskill Creek in Schoharie County. In the Buffalo region it is a dark, subcrystalline, dolomitic limestone in uneven layers, which are only a few inches thick and are separated by carbonaceous seams. It weathers to a buff or brown and often becomes porous due to the weathering out of a small fossil and the crystallization of supposed magnesium sulphate in the limestone mud. When of this porous character it is called " bullhead " or " pumpkin head " limestone. It stands weather better than the Bertie. In eastern New York the rock often breaks up into long narrow blocks and is usually a typical lime sandrock. It is used locally to quite an extent and is also important agriculturally.

The following samples show its composition in western New York.

COMPOSITION OF COBLESKILL DOLOMITE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
96*	Buffalo, Erie Co...	98.04	52.40	38.45	90.85	6.58	2.57
97*		98.52	51.66	39.48	91.14	6.08	2.78
98		98.56	51.87	39.33	91.20	5.96	2.84
99		98.72	48.96	41.92	90.88	5.74	3.38
114	Phelps, Ontario Co.	94.24	60.78	28.20	88.98	7.64	3.38
115		96.12	58.85	31.50	90.35	6.92	2.73
116		89.84	59.50	25.60	85.11	12.00	2.89

* Ground limestone.

BERTIE WATERLIME. (20)

This formation outcrops along with the preceding two and takes its name from a town in Ontario, Canada, west of Buffalo. It overlies the gypsum of the Camillus group, and in the Syracuse region is about 50 feet thick as a maximum. It is buff or gray in color, evenly but thinly bedded. The layers are usually separated by carbonaceous matter. In some places large salt cavities occur. In the Hudson River Valley the lower waterlime bed is known as Rosendale waterlime and is quarried for cement. The Bertie is also used for cement in western New York, usually the layers just below the Cobleskill. Its agricultural use is limited. Its type locality is at Bertie in Canada, not far from Buffalo.

ROSENDALE WATERLIME. (21)

This formation is very closely related geologically to the Bertie (see Bertie Waterlime). It is confined to a rather small area in eastern New York. In the Schoharie region it is about 22 feet thick. The type locality is at Rosendale in Ulster County.

DECKER FERRY LIMESTONE. (22)

This formation is the equivalent of the Bertie of western New York. Its type locality is at Decker Ferry. It is found in Orange and Ulster counties, the section at Accord, Ulster County, being practically a complete one. In the Skunnemunk Mountain region in Orange County it is closely associated with the Cobleskill. In character it is usually brownish in color. Some of the layers are massive, with shaly partings. Corals are abundant. The stone usually contains appreciable quantities of magnesium, as shown by the analysis of several typical samples. Its agricultural use is very limited.

COMPOSITION OF DECKER FERRY LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
48	Accord, Ulster Co.	84.44	71.22	11.14	82.36	11.96	5.68
49*		80.50	68.24	10.33	78.57	12.80	8.63

* Ground limestone.

GUELPH AND LOCKPORT DOLOMITES. (27 & 28)

These formations, embraced under the term Lockport series, are confined to western New York and reach a thickness in the Niagara region of over 260 feet, their type localities being at Guelph in Ontario, Canada, and at Lockport in Niagara County. This series is characterized by two distinct faunas. In the region of Rochester and above the Rochester shale are 62 feet of Lockport Dolomite followed by three feet of Guelph Dolomite known as Lower Shelby. Then follows 32 feet of Lockport Dolomite and finally 8 to 10 feet of Guelph dolomite, the latter known as Upper Shelby. The lower portion of the series contains considerable clay as a transition from the shales below. The formation is also called Niagara limestone. It is usually a very dark, in places a black, dolomite, containing many cavities or geodes lined with calcite or dolomite crystals. In places it is often somewhat concretionary and at other horizons highly bituminous indicating probable coral reef origin. It is quite resistant and often shows strong relief. A large part of it is heavily covered with drift. Some parts of the formation make a fairly good building stone. It is also used to some extent for agricultural purposes. Both formations are usually distinctly dolomitic. Some typical samples of Lockport showed the following composition.

COMPOSITION OF LOCKPORT DOLOMITE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
67	North Rose, Wayne Co.	103.36	54.78	40.93	95.71	2.16	2.13
84*	Medina, Orleans, Co.	105.44	53.75	45.08	97.30	2.42	0.28
85*		104.92	53.75	45.50	96.11	2.52	0.62
	Lockport, N. Y. . .	95.95	56.19	33.42	89.61	......	....
			Guelph	*Dolomite.*			
	Rochester........	107.53	56.01	43.30	99.31	......	....

* Ground limestone.

IRONDEQUOIT LIMESTONE. (29)

This formation is the upper limestone member of the Clinton beds and is confined to western New York, its type locality being at Irondequoit in Monroe County. It consists of numerous layers of limestone separated by bands of shale. The lower shale is greenish and the upper gray in color. Some of the rock is crystalline in structure being made up of broken corals and shells. At the top of the formation are numerous reef-like, lenticular structures made up of masses of bryozoan fossils, while the Rochester shale above is often arched over these masses. The rock is variable in composition and often contains much iron pyrite, giving it a red color. It is of small importance commercially at present.

WOLCOTT LIMESTONE. (30)

This limestone occurs along with the Irondequoit and Lockport, in western New York. The Wolcott and Irondequoit formations together are known as Clinton limestone. The type locality for the Wolcott is at the place of that name in Wayne County. At Rochester the formation is 14 feet thick. It has a crystalline appearance and considerable power of resisting heat; therefore has been used to some extent as a firestone for chimneys and hearths. It contains many associated minerals such as gypsum, barite, chalcopyrite and quartz. Agriculturally it is beginning to be utilized to some extent. It is a calcium stone, containing usually 3 to 7 per ct. magnesium carbonate.

The following samples from a quarry at Pekin in the Niagara region, gives an idea of its composition.

COMPOSITION OF WOLCOTT LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
110*	Pekin, Niagara Co.	92.90	85.00	6.66	91.66	5.01	3.32
111*		92.24	84.58	6.45	91.03	4.86	4.11
113		98.28	94.16	3.47	97.63	0.62	1.75
112		98.24	93.12	4.31	97.43	0.26	2.31

* Ground limestone.

TRENTON LIMESTONE. (31)

From an agricultural standpoint the Trenton ranks as one of the most important limestones of the State. It is widely distributed through central, east central and northern New York. It varies in thickness from very little to 475 feet in Lewis County. It is a strictly calcium stone often containing as high as 96 to 98 per ct. calcium carbonate. Its type locality is at Trenton Falls in Oneida County. Typical outcrops consist of dark, thin-bedded, irregular, compact limestone, with shaly partings. Many of its beds are a mass of fossil shells. With the thin beds are often associated thicker, almost massive, beds of dark blue stone which are more abundant in the upper Trenton than in the lower. The upper extreme portion is very shaly, forming transition beds to the Utica Shale. The stone is quite soluble and easily dissolved out by streams, often forming stream gorges. Brachiopod, trilobite, coral and crinoid fossils are abundant. The upper portion of the formation is used for building. Enormous quantities of the stone have been burned and many quarries are producing lime and limestone for agricultural use.

COMPOSITION OF TRENTON LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
17	Prospect, Oneida Co.	94.40	92.72	1.42	94.14	4.90	0.96
18		96.12	96.00	......	......	2.36	....
19	Salisbury, Herkimer Co.	89.78	89.68	......	......	7.28	....
20		95.52	95.43	......	......	3.30	....
30	St. Johnsville, Montgomery Co.	91.92	85.28	5.60	90.88	4.34	4.78
31		93.80	93.47	......	......	5.03	....

GLENS FALLS LIMESTONE. (32)

This limestone is the basal member of the Trenton beds and occurs in the vicinity of Glens Falls, Warren County, which is its type locality. In the region of Saratoga it reaches a thickness of 50 feet, where it overlies the Amsterdam limestone. It is usually thin-bedded, with shale partings. Fossils are numerous. At the base is a thin conglomeratic layer, indicating, along with pebbles in other portions, that the formation is probably of shallow water origin. It is used to some extent commercially and agriculturally.

COMPOSITION OF GLENS FALLS LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
23	Canajoharie, Montgomery Co.	76.32	58.92	14.66	73.58	23.07	3.35
24		85.44	78.62	5.75	84.37	13.94	1.69
26		96.64	96.36	......	......	2.22	....
34	Saratoga, Saratoga Co.	96.72	92.12	3.90	96.02	1.78	2.20

AMSTERDAM LIMESTONE. (33)

Underlying the Glens Falls limestone in the Saratoga and Glens Falls region is about 10 feet of limestone known as Amsterdam. It reaches a maximum thickness of 50 feet. Its type locality is at Amsterdam in Montgomery County. It is a pure, massive, gray to blue crystalline stone. At Glens Falls it is quarried as so called "Black Marble." It is usually somewhat thin-bedded, crystalline and fossiliferous. Commercially it is an excellent source of quicklime and ground limestone. Calcium carbonate usually runs high, often as much as 98 per ct. with very little magnesium. The samples from Glens Falls show its high calcium character.

COMPOSITION OF AMSTERDAM LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
25	Canajoharie, Montgomery Co.	88.44	81.33	5.99	87.32	8.94	3.74
32	Glens Falls, Warren Co.	99.08	98.46	......	......	0.98	....
33		98.68	97.50	0.98	98.48	1.31	0.21

WATERTOWN LIMESTONE. (34)

This formation is confined largely to the Thousand Island region and belongs to the so-called Black River beds which reach a maximum thickness of 71 feet in the Champlain Valley. Its type locality is at Watertown in Jefferson County. It is a solid bank of dark bluish gray to black limestone with indistinct bedding planes. When fresh it is very hard and contains numerous calcite crystals, worm tubes and sand seams. The fresh stone furnishes large blocks but weathers to smaller blocks. The formation contains one layer known as the 7-foot tier. Above this tier the stone is black, knotty and impure and contains much organic matter, while the cavities and chambers of the fossils present are often filled with petroleum. It is of some importance as a source of lime.

LERAY LIMESTONE. (35)

This is another member of the Black River Beds. It is sometimes considered as the upper part of the Lowville in the Thousand Island Region, where it is about 13 feet thick. Its type locality is Leraysville in Jefferson County. It is a dark gray to black or dove-colored limestone, heavily bedded with layers of black chert nodules intermixed. Weathering breaks the stone into small cubical blocks the size of the fist, caused by the presence of mud seams. It is of less importance agriculturally than the Watertown or Lowville.

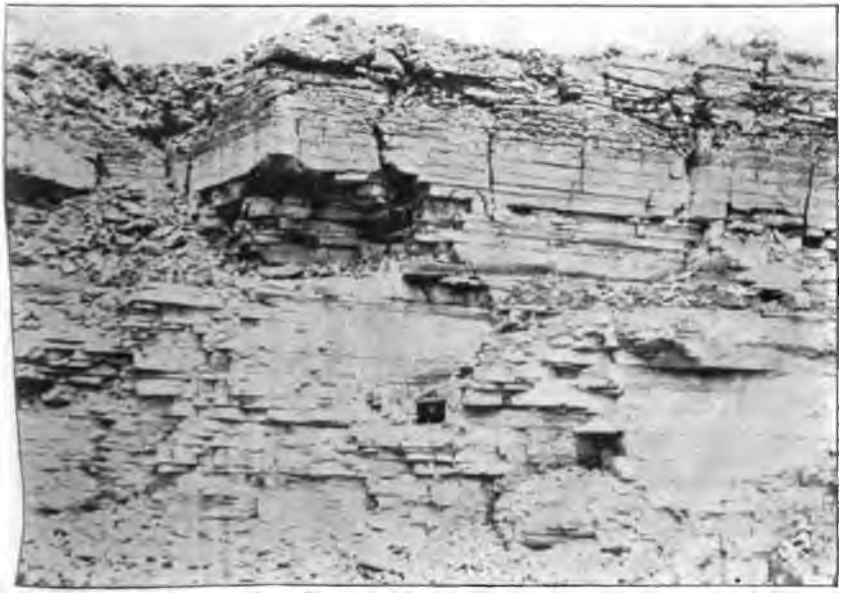
LOWVILLE LIMESTONE. (36)

This is the so-called "Birdseye Limestone," also a member of the Black River Beds. It is quite widely distributed in northern and north central New York. On the Black River it attains a thickness of 60 feet; type locality at Lowville in Lewis County. It is an impalpably fine grained stone of light dove color and filled with dark colored vertical, columnar fucoidal stems. The fracture is smooth and conchoidal, the stone being rather brittle. These fucoidal stems are those of a branching coral and being replaced by calcite, appear on the surface of the stone as "birdseyes", hence the name. It is usually fairly thick-bedded, with vertical jointing. It weathers to a whitish or light ash gray tint which is characteristic. This stone is quite important commercially, being used for building and to considerable extent for agricultural purposes. It is usually a rather pure calcium stone varying from 90 to 97 per ct. calcium carbonate. Its composition is indicated by the analysis given in the table below.

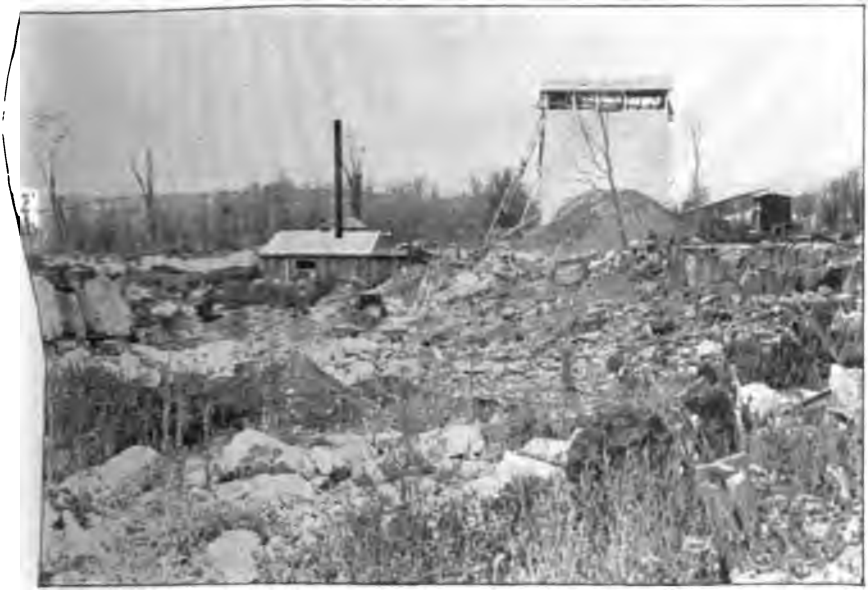
COMPOSITION OF LOWVILLE LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1	Chaumont, Jefferson Co.	97.40	96.20	1.02	97.22	1.78	1.00
2		94.16	89.66	3.80	93.46	4.80	1.74
3		93.76	89.26	3.80	93.06	5.27	1.67
4*		93.76	92.93	......	......	5.79	....
8*	Denley, Oneida Co.	93.30	92.50	0.67	93.17	5.74	1.09
9		97.40	97.55	......	......	1.99	....
10		95.76	95.41	......	......	3.50	....
11		96.84	79.41	14.68	94.09	2.40	3.51
92†		94.92	92.70	1.87	94.57	3.07	2.36
93*		91.64	90.62	.86	91.48	5.78	2.74
94*		86.28	84.80	1.25	86.05	9.74	4.21
95*		96.16	93.75	2.03	95.78	3.18	1.04
89	Newport, Herkimer Co.	92.24	89.37	2.42	91.79	6.38	1.83
90		90.00	87.92	1.75	89.67	6.90	3.43
154		90.8	87.7	2.60	90.30	8.4	1.30
155		91.8	90.6	1.00	91.60	6.00	2.40

* Ground limestone. † Screenings.

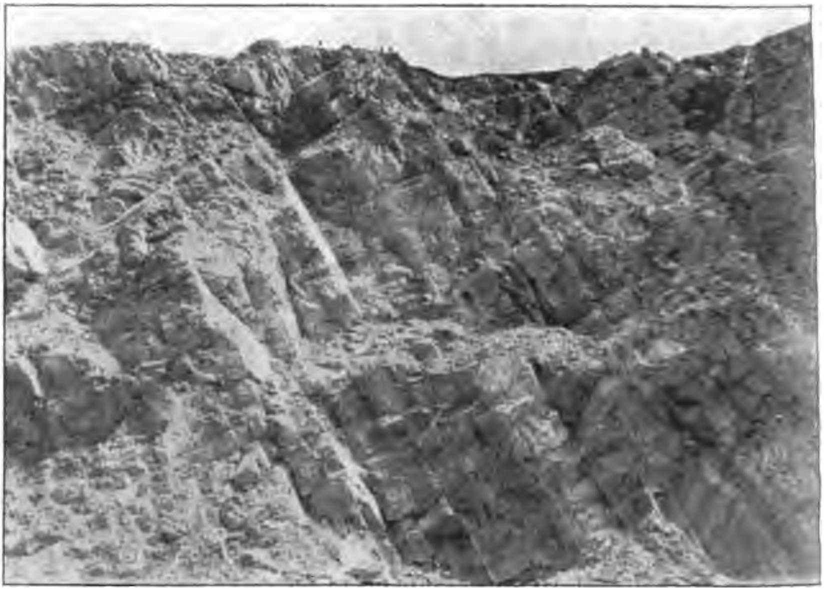


Lowville Limestone near Newport, N. Y.

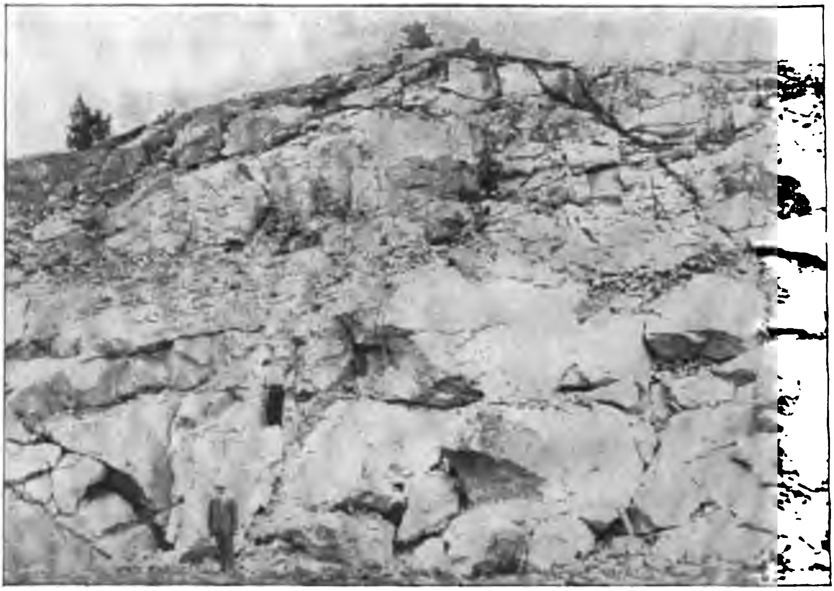


Grinding Plant in Lowville Limestone near Booneville, N. Y.

PLATE V.



Crystalline Limestone near Verplanck Point on the Hudson River.



Crystalline Limestone (Franklin) near Pine Island, Orange County.

PLATE VI.

CHAZY LIMESTONE. (37)

The Chazy formation, though confined to the Champlain Valley, is an important limestone commercially and in point of thickness, being 890 feet thick on Valcour Island in Lake Champlain. Its type locality is at Chazy in Clinton County. It is made up of three members and on Valcour Island their relations are as follows:

1. Valcour Limestone, or Upper Chazy, 202 feet thick. The lower layers are dove colored, compact, more or less massive limestone. The upper layers are arenaceous, magnesium limestone passing into fine sandstone. The stone is primarily a calcium one usually having 95 per ct. or more of calcium carbonate.
2. Crown Point Limestone, or Middle Chazy — 350 feet thick. This division is a nodular stone below and a heavy massive pure stone above. The main mass is bluish black in color and thick-bedded with a fine grain, weathering to a lighter color.
3. Day Point Limestone or Lower Chazy — 338 feet thick. This lower division is sandy at the base while the main part is dark blue to gray and somewhat impure. The beds are 8 to 20 feet thick, rather uneven, and separated by seams of earthy matter.

The Chazy limestone is an important one in the lime industry of northeastern New York, furnishing abundant material for lime, flux and ground limestone. It is a high calcium stone, often containing 98 per ct. calcium carbonate and only a small amount of magnesium. Its character can be seen from the analyses given.

COMPOSITION OF CHAZY LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
56*	Chazy,	92.40	89.00	2.88	91.88	5.22	2.90
57	Clinton Co.	95.00	93.18	1.53	94.71	1.15	4.14
58		96.40	94.86	1.30	96.16	1.25	2.59
59		96.60	94.44	1.82	96.26	1.82	1.92

* Ground limestone.

PAMELIA LIMESTONE. (38)

The Pamelia formation in its typical outcrops is found in Jefferson County and the Thousand Islands region, where it reaches a thickness of 150 feet. Its type locality is at Pamelia in Jefferson County. The basal portion consists of a sandy conglomerate, above which are calcareous sandstones. Then follows the main mass of the formation which consists of thin and thick beds of whitish gray to blue gray impure limestone. Some of the upper gray beds are magnesium in character and have been burned for cement locally. As a whole the formation is a mass of earthy limestones of no great importance agriculturally.

BEEKMANTOWN FORMATION (CALCIFEROUS). (39)

In the Champlain Valley this formation assumes great thickness (1800 feet) although it is not a limestone throughout. In fact in the distribution through northeastern, eastern and southeastern New York it contains admixtures of sandstones in most places. According to fauna and lithic character the formation is divided into 5 divisions usually designated as A, B, C, D and E, the latter one, E, together with part of D, being known as Cassin beds.

The Cassin beds (690 feet) consist of sandy limestones with thin beds of blue limestone. The upper part is a fine-grained, magnesium stone weathering to drab or yellow. Divisions C (350 feet) and D (in part 155 feet), besides sandstones, also contain magnesium limestones, part of C having some rather thick beds. Division B (295 feet) consists of dove limestone intermingled with gray dolomite in massive beds 12 to 15 feet thick. This division contains some good limestone. Division A (310 feet) consists of dark gray magnesium limestone in 1 to 2 foot layers. The stone is impure containing nodules of chert and other silicious matter.

From its rather mixed and impure character the Beekmantown is of less importance than some of our other formations. A few quarries, however, are using Beekmantown for agricultural purposes. Calcium carbonate rarely runs over 50 per ct. while the stone may contain as high as 30 per ct. magnesium carbonate. The composition of the samples in the table shows its magnesium character.

COMPOSITION OF BEEKMANTOWN LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
54	Ogdensburg,	76.24	41.08	29.62	70.70	27.70	1.60
55	St. Lawrence Co.	84.28	48.40	30.23	78.63	17.49	3.88

TRIBES HILL LIMESTONE. (41)

This formation is correlated with the Beekmantown of the Champlain Valley. It is found in the Mohawk Valley in the region of Tribes Hill, Montgomery County, where it is 168 feet thick, also in the Thousand Islands region, where it has a thickness of 30 feet.

The name "fucoidal" is sometimes applied to this limestone. It is usually a dark blue, fine-grained stone, somewhat arenaceous, and contains fucoidal markings. It weathers nearly white in places. The layers are often rather massive and resemble the Lowville to some extent. It is of some importance agriculturally.

LITTLE FALLS DOLOMITE. (42)

The name indicates the locality in which this dolomite is found. In the Saratoga region it reaches a thickness of 400 feet. The stone is of rather uniform character throughout, being a pale blue-gray, fine-grained crystalline, dolomitic limestone. It weathers to a light gray or buff. It is distinctly bedded in layers 1 inch to 18 inches thick. A striking feature of this stone consists of cavities lined with quartz crystals and sometimes dolomite and calcite crystals. The quartz crystals are remarkable for clearness and such rock is known as "diamond" rock. Twenty to 40 feet above the base is a persistent layer of angular chert fragments, while cavities occur at places filled with carbonaceous matter resembling anthracite.

This stone is of considerable importance commercially. It makes a lime which sets very hard but is difficult to slake. It is distinctly dolomitic, rarely containing less than 20 per ct. magnesium carbonate, and more than 55 per ct. calcium carbonate. The few samples analyzed indicate its general character.

COMPOSITION OF LITTLE FALLS DOLOMITE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
79†	Pattersonville, Schenectady Co.	69.60	44.18	21.42	65.60	30.18	4.22
80		93.04	52.70	33.99	86.69	10.90	2.41
81		82.72	50.57	27.10	77.67	21.15	1.18

† Dust.

HOYT LIMESTONE. (43)

This formation derives its name from a quarry in the Saratoga region where the rock outcrops. In this region its maximum thickness is 100 feet. It is sometimes regarded as a basal phase of the Little Falls. The formation is found in a number of localities in Saratoga and Washington counties. The formation consists of alternating beds of limestone and dolomite, usually thin-bedded and dark to black in color. In the lower part several beds of black oolite occur and fossils are numerous. There are very few massive beds and the dip of the strata is strongly southwest. Its local occurrence gives the stone only limited commercial value.

THERESA DOLOMITE. (45)

This formation forms a perfect transition between the Potsdam sandstone and the Little Falls dolomite. It is found mainly in the Thousand Islands region where it is about 70 feet thick and in the Saratoga region where it attains a thickness of 200 feet. Its type locality is at Theresa in Jefferson County.

The formation consists of alternating beds of pure-gray, fine-grained sandstone and blue-gray, fine-grained dolomitic limestone. The beds are usually rather thin. The dolomite closely resembles the Little Falls. It contains similar cavities lined with calcite and quartz crystals. The base of the formation is very sandy. Ripple marks and cross bedding are common. In places this limestone is sufficiently pure for industrial use. Its agricultural value at present is small.

WAPPINGER AND FISHKILL LIMESTONES. (46)

In southeastern New York, especially in Dutchess, Ulster and Orange Counties, are two rather peculiar belts of limestones which on account of their position and complex origin are considered together. Both are complex in structure, having been greatly crushed and changed from their original condition. Their age varies from lower Cambrian to Trenton.

COMPOSITION OF WAPPINGER LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
38	Newburgh, Orange Co.	100.76	56.70	37.12	93.82	2.61	3.57
39		100.12	55.78	37.35	93.13	5.16	1.71
40	Lagrangeville, Dutchess Co.	99.52	56.21	36.50	92.71	5.74	1.55
41		101.84	56.14	38.50	94.64	4.55	0.81
42		103.68	60.04	36.76	96.80	1.78	1.42
159†	Stoneco, Orange Co.	63.8	35.5	23.8	59.3	39.76	.94
161		105.2	55.6	41.8	97.4	1.84	.76
162		105.7	55.4	42.4	97.8	1.38	.82

* Ground limestone. † Used for asphalt.

The western belt is referred to as Wappinger (sometimes Barnegat) limestone and occurs along Wappinger Creek in Dutchess County. The eastern belt occurs around Fishkill Village, north of the Fishkill Mountains, and is known as Fishkill Limestone.

These limestones were originally water lain but have since been changed by folding, crushing and intrusions of other rocks into them, so that at present we find them mixed with slates, gneisses, quartzites, and many other intrusions. Their composition varies from high calcium to dolomitic. In many places the stone is compact, fine in texture, dark to light in color and strongly bedded. Much of it is massive. Even where stratification is plainly indicated the stone varies in character. In some places it is very finely crystalline, being almost a micromarble. Fossils are scarce.

The Wappinger belt is thought to be over 1000 feet thick. Both belts contain some good limestones which have considerable importance commercially. A number of samples analyzed were rather pure dolomites, containing as high as 40 per ct. magnesium carbonate.

INWOOD LIMESTONES. (48)

To the south of the Wappinger-Fishkill belts is another belt of metamorphic limestones known as Inwood (sometimes Stockbridge Dolomite). It runs as far south as New York City where it is 200 to 800 feet thick. Inwood is a locality in New York City near the Bronx. This limestone is everywhere coarsely crystalline, either massive or strongly bedded. Like the Wappinger and Fishkill limestones, it contains quantities of secondary minerals such as mica, quartz and silicates. It is essentially a dolomite. In many places

COMPOSITION OF INWOOD LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
35*	Verplanck Pt., Westchester Co.	93.32	51.10	35.57	86.67	10.50	2.83
36†		88.80	49.70	32.94	82.64	15.22	2.14
37		92.60	50.61	35.38	85.99	12.86	1.15
43†	Dover Plains, Dutchess Co.	94.08	53.76	34.00	87.76	5.47	6.77
44		99.08	51.77	39.86	91.63	5.87	2.50
45§		103.40	54.08	41.55	95.63	2.19	2.18
158	Verplanck Pt.	76.8	46.3	25.7	72.0	26.2	1.80
171		79.7	47.5	27.1	74.6	22.0	3.40

* Screenings. † Dust. ‡ Ground limestone. § Natural dolomitic sand.

it weathers to a fine, white, dolomite sand, so that the soil in those regions is often heavily charged with such sand. Many of the beds are nearly vertical so that weathering and decay take place to great depths. It contains no fossils. The Inwood limestone is quite important industrially. A number of quarries are using it for production of agricultural lime. It often contains almost the theoretical dolomite percentage of calcium and magnesium carbonate.

GRENVILLE AND FRANKLIN LIMESTONES. (49)

These two limestones are representatives of the Precambrian in New York. The Grenville is erratically distributed through northern and northeastern New York, the Franklin is found in only a small locality in southern Orange County. The term Grenville is from Grenville in Canada and includes a great series of limestones, gneiss, quartzite, schist, etc. These formations are highly metamorphosed sediments, among the oldest rocks of which we have any knowledge. They are always highly crystalline, with great range of color, from pure white to dark blue-gray. They often contain scattered particles of other minerals such as the silicates, serpentine and tremolite, also graphite, pyrite, titanite and many others. The Grenville of northern New York occurs in certain broad belts and seems to favor the surface depressions indicating that intervening beds have probably been eroded away. Little evidence of bedding is present in the outcrops. In composition they vary from very high

COMPOSITION OF THE GRENVILLE LIMESTONE.

Lab. No.	SOURCE OF SAMPLE.	Carbonate equivalent.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Insoluble matter.	Iron, alumina, water, etc.; by difference.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
5	Natural Bridge, Jefferson Co.	96.40	94.86	1.27	96.13	3.72	0.15
6		91.70	90.65	0.88	91.53	8.38	0.10
7		108.00	57.81	42.28	100.09	0.16	....
	Canton.	100.1	88.67	9.53	98.20	......	....
		98.36	76.49	19.97	96.46	......	....
	Gouverneur.	98.56	92.29	4.28	96.57	......	....
160	Pine Island, Orange Co.	96.6	94.5	1.80	96.3	2.14	1.56
172		97.6	94.5	2.60	97.1	1.42	1.48
173*	Gouverneur.	96.6	89.0	6.40	95.4	3.18	1.42
174		99.1	92.3	5.70	98.0	1.22	.78

* Ground limestone.

calcium stone to practically pure dolomite. In the regions where they are found, especially the Grenville, they are of importance commercially, being quarried for marble, burned for lime and ground for agricultural use. Some of the high calcium stone contains as much as 97 to 98 per ct. calcium carbonate, while the magnesium stone is often a pure dolomite.

LIMESTONE MAP.

The limestone map which accompanies the bulletin attempts to show the extent of outcrop of the more important limestone formations or groups of formations. This cannot be done very much in detail on so small a scale, but it gives at a glance a general idea of the limestone resources of the State as a whole. For more detailed descriptions the reader will find it very profitable to consult the geological surveys of various sections of the State. A list of those published can be obtained on application to the New York State Museum, Albany.

Since in this State the natural outcrops of nearly all rocks is largely covered with glacial drift or glacial lake deposits, the areas of workable limestone are by no means as extensive as may at first be inferred from the map. Nevertheless limestone of all grades can be obtained in quantities that seem inexhaustible.

Where a formation is distinctly interstratified with limestone and calcareous shales it is all represented on the map as a limestone formation, although the area of actual limestone may be much smaller than indicated by the extent of the coloring. This is true of the Niagaran group and of some of the formations represented in St. Lawrence and Jefferson counties.

STRATIGRAPHIC COLUMNS.

It is difficult to show on a flat map the stratigraphic relations of limestones on account of the many other formations which separate them, and also from the fact that two formations equivalent in age may be quite different in character. The attempt has been made to show these relations by columns and conventions.

On account of the many formations of equivalent age but different character, it has been found necessary to prepare two sets of columns, one for the eastern and one for the western half of the state. These columns show the relative age of each formation and its stratigraphic position in relation to other formations. The vertical divisions in the column indicate that the formations so represented are of equivalent age but quite different in lithologic or faunal character.

The great thickness of some formations (for example the Catskill and Oneonta beds, 2000 to 3000 feet thick) could not be shown in columns of sufficient scale to show the limestones also, so such thicknesses are indicated by breaks in the column.

The approximate thicknesses in feet, together with the corresponding localities, are also given on the left of the columns opposite each formation. Each half of the state has been divided into three sections east and west, and on the right of the stratigraphic columns these divisions are given with the formation and group names opposite the corresponding connections in the columns. Where the stratigraphic column is divided vertically the divisions correspond with the written legends at the right.

It is not the purpose to convey the impression that the columns are an accurate representation of geological succession, since many of the details of stratigraphy are at present obscure, while many points are still coming to light in regard to certain formations and their time relations. The columns are rather an attempt to show in a graphic way with reasonable accuracy the geological relation and comparative age of our limestones, with a view toward making them more familiar and understandable.

TYPES OF LIMESTONE.

An absolutely pure limestone would be composed of 100 per ct of calcium carbonate ($CaCO_3$), and such purity is approximated in the crystal forms such as Iceland spar and aragonite.

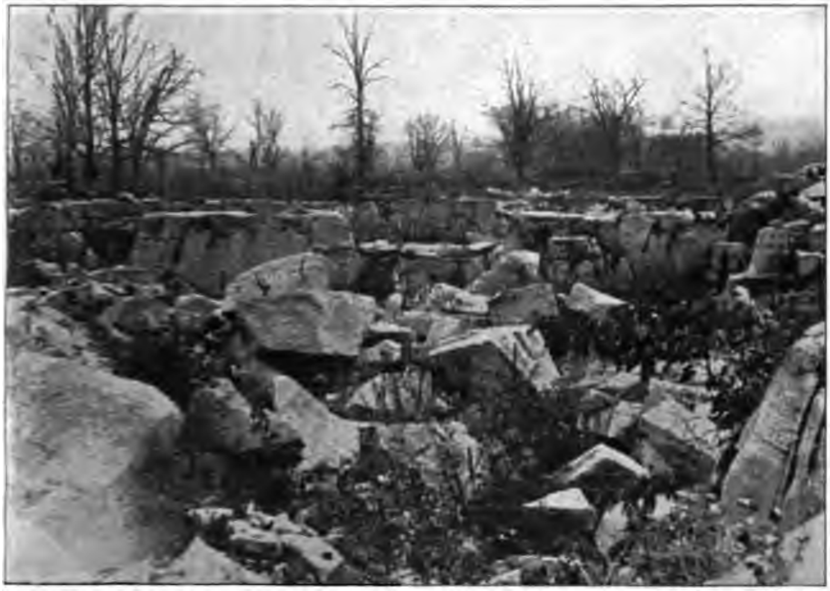
With the development of our limestone resources the term limestone and lime have gradually acquired a broader meaning and now include besides our purer calcium stones, our dolomitic stones also, and all gradations between the two. The materials usually present as impurities in limestone are silica, alumina and iron, which are almost always present to some extent, and traces of many salts and minerals, especially the clay silicates. Besides these constituents there is also present in most stones more or less organic matter, which may be a trace or in such quantity that the stone approaches a bitumen in character. The characteristic color of limestone is due to the presence of this organic matter, except in some cases in which it is influenced to considerable extent by iron compounds; for example the Irondequoit limestone. The relative percentage of impurities present in the stone roughly divides our more important carbonate rocks into a number of groups with more or less arbitrary lines of differentiation.

We may have a stone which contains a high percentage of sand which results in a silicious limestone. If the sand predominates the stone would be a calcareous sandstone.

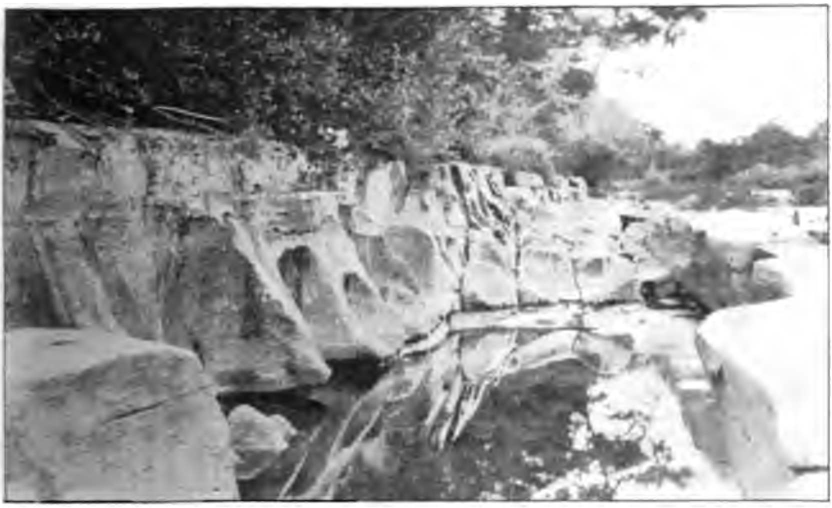
If clay is present in quantities exceeding the carbonates we have a calcareous shale, or vice versa, a shaly or argillaceous limestone. All kinds of variations occur.

The second and more important classification of carbonate rocks is based on chemical composition. On this basis we have three types:

1. Calcium limestones.
2. Magnesium limestones, including dolomite.
3. Hydraulic limestones or waterlimes.



Lowville Limestone, Showing Weathering Effect of Solution Along the Joint Planes.



Lowville Limestone. Pot Holes Showing Solubility of Limestone in Running Water.

PLATE VII.

U. M.

The first class includes those stones which are of high calcium content. It includes such stones as the Lowville, Trenton and Tully.

Stones of the second class contain appreciable quantities of magnesium carbonate, such as the Beekmantown, Little Falls, Lockport, and Wappinger formations. All limestone contains some magnesium, but only those in which the percentage of magnesium begins to be an important factor industrially are called magnesium stones. This class also includes dolomite or dolomitic limestone which, on account of its importance, is discussed in detail below.

The third class includes impure stones containing either calcium or magnesium carbonates or both, along with admixtures of clay. They have the property of setting into a hard mass when burned and moistened. They are the basis of the natural cements. The Rondout, Bertie, Rosendale and Cobleskill may be cited as examples. This class is of relatively small importance agriculturally as the majority of waterlimes are low in carbonates and could not compete in price with the higher grade stones.

Mention should also be made of marble which may belong to either class 1 or 2. It is metamorphic in origin and differs from ordinary limestone mainly in its highly crystalline texture. The marbles are found only in our oldest formations.

The importance of high magnesium limestones, especially from an agricultural standpoint deserves special mention.

Nearly all limestones contain some magnesium carbonate. The percentage may vary from a trace to over 45 per ct. If the percentage runs over 40 the stone is considered a practically straight dolomite; between 30 and 40 a dolomitic or high magnesium limestone, and over 10 per ct. simply a magnesium limestone.

The origin of the dolomites is somewhat obscure. Pure dolomite is made up of 54.27 per ct. of calcium carbonate and 45.73 per ct. magnesium carbonate and has the composition of a double carbonate $CaMg\ (CO_3)_2$. It is not a mixture of the two carbonates but a distinct mineral species with a definite chemical formula.

The significance of magnesium limestones to agriculture is discussed in Bulletin 400 of this Station. The chemical analysis of the different stones indicates which are magnesium and dolomitic.

ORIGIN OF LIMESTONE.

Calcium and magnesium are among the most abundant elements in the earth's crust. Calcium constitutes 0.05 per ct. of the ocean, magnesium 0.14 per ct. Calcium makes up 3.42 per ct. of the known crust of the earth, magnesium 2.27 per ct. Prior to the formation of sedimentary limestones the calcium and magnesium now contained in them existed in the form of such minerals as calcite, anorthite, garnet, epidote, amphibole, pyroxene, dolomite, mica, olivine, talc, serpentine, chlorite and others.

Carbon dioxide is present in the atmosphere to the extent of about three parts in ten thousand. Sea water at ordinary temperatures dissolves about 45 milligrams of carbon dioxide per liter.

Carbon dioxide in water forms the so-called carbonic acid which has well-known weak-acid properties. This weak acid has the power of gradually decomposing silicates, transforming them into carbonates. Thus the mineral tremolite when acted upon by carbonated water gradually undergoes the following transformation:

$$\underset{\text{Tremolite}}{Mg_3\,Ca\,Si_4\,O_{12}} + \underset{\substack{\text{Carbonated}\\ \text{water}}}{H_2CO_3} \rightarrow \underset{\text{Talc}}{Mg_3\,H_2\,Si_4\,O_{12}} + \underset{\text{Calcium carbonate}}{CaCO_3}$$

The mineral augite, in a similar way, passes over into carbonates of calcium, magnesium and iron, leaving behind ordinary clay, iron oxide and silica. This carbonation process is universal in nature and contributes more of the material dissolved in waters which flow from the land than any other process. Now these resulting calcium and magnesium carbonates are quite appreciably soluble in carbonated water. Pure water will dissolve about 0.0131 gram calcium carbonate per liter, while carbonated water dissolves about 0.385 gram or thirty times as much.

Many marine plants and animals use calcium carbonate in their metabolic processes for skeletal and housing purposes. They derive it from this dissolved carbonate, and as these organisms die their remains fall to the ocean floor and accumulate. The increasing weight of these accumulations has exerted pressure on the mass beneath which, together with the cementing properties due to partial resolution in the moisture present, has gradually raised the specific gravity of the mass and given it the hard limestone texture. This has been the main method of limestone formation and has required a vast period of time.

Since most of these lime-secreting organisms live only in depths of water to which light penetrates, it follows that our limestones were laid down in comparatively shallow water. The main forms of organisms contributing to this formation are the lime-secreting algae. The red algae have contributed a large part of the calcareous substance of coral reefs which make up some of our limestone formations.

The protozoa, foraminifera, coelenterata and mollusks have also contributed a part. This organic process of limestone formation is still going on as proven by the deposition of calcareous shells on the ocean floor, the development of coral reefs and the formation of marl in swamps.

Besides limestone of organic origin we may also have calcareous deposits formed by chemical means. We are all familiar with the deposition of lime in teakettles in which hard water has been boiled repeatedly. Natural waters all contain carbon dioxide in solution which, as before stated, holds calcium and magnesium carbonates in solution. Boiling or other means of withdrawal drives off this carbonic acid gas, whereupon the carbonates are precipitated out of solution and collect as a deposit. Similar processes go on to a great extent in nature. Thus when waters highly charged with calcium carbonate come to the surface some of the carbon dioxide held by pressure is released, precipitating part of the calcium carbonate. This can be seen around hot springs where the material is known as calcareous sinter, tufa or travertine. Again when plants growing in water charged with carbon dioxide gradually withdraw this constituent for their growth, the carbonate held in solution is precipitated. On a small scale this process is finely illustrated by the so-called " water biscuit " of Canandaigua Lake, N. Y., which is thought to be of this origin. Limestone of chemical origin, however, is insignificant in quantity when compared with that of organic origin.

ALFALFA ON LAND NOT NATURALLY ADAPTED TO THAT CROP.*

J. F. BARKER.

Alfalfa is naturally adapted to well-drained limestone land; and on such soils it can be grown with very little difficulty. Wherever such land occurs in this State it will usually be found that alfalfa has been grown to some extent in that community for many years. But real limestone soils do not form a very large percentage of the farm land of New York State. The biggest problem in connection with the growing of alfalfa here is its successful production on land not naturally adapted to it.

Soils not naturally adapted to alfalfa.— Practically all soils deficient in lime carbonate are poorly adapted to alfalfa and cannot be made to grow that crop successfully until a certain amount of lime is supplied. Such soils comprise at least three-fourths of the farm lands of this State; they may be referred to as non-calcareous soils and the natural alfalfa lands as calcareous. There is a great variation as to the number and extent of the difficulties to be overcome in preparing these lands for alfalfa; and the soils may be classed somewhat according to their variations in this respect.

1. In the first class of these non-calcareous soils may be grouped well-drained bottom-lands along rivers and streams. Such lands often present but little difficulty in the growing of alfalfa. They are not very acid, they usually present a good state of general fertility, have deep porous subsoils and are well supplied with moisture. A comparatively light application of lime usually makes a good alfalfa soil out of this type.

2. The second class may include deep glacial drift soils, and material worked over by glacial waters, outside the influence of limestone formations. This class, as a rule, requires more lime than the first, but two to four tons of ground limestone per acre will usually suffice. On level areas drainage is necessary unless there is a deep porous subsoil. Of course, such lands vary greatly in their general fertility. This class of soils occurs principally in the counties bordering Lake Ontario and Lake Erie, to some extent in the larger river valleys and on a considerable part of Long Island. In this class may perhaps be included also river terraces in any part of the State outside of limestone areas.

3. In the third class, according to degree of difficulty of growing alfalfa, may be placed the sand hills and ridges occurring in different sections of the State, notably in the west central portion and

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* A reprint of Circular No. 39, April 20, 1915.

on Long Island. It is often difficult to get alfalfa started on soils of so light texture, yet it is very desirable to grow the crop on these lands, for it checks erosion and proves a great help in the management and improvement of this type.

4. In this class would come the better drained portions of the non-calcareous hill lands in the southern and eastern parts of the State. In the case of this and the following class it has until recently been supposed altogether impracticable to attempt to grow alfalfa at all; and at the present time one may travel by automobile an entire day in these sections without seeing an alfalfa patch. Heavy applications of lime are required here to make alfalfa a success. Lime-requirement determinations often indicate five to ten tons of limestone per acre. Then there is a large amount of general fertility to be supplied and in addition there is much trouble with heaving in the late winter and early spring. But alfalfa can be successfully grown on such land and it is well worth all it costs to get it started. The growing of this crop will enable $25-an-acre land to pay high interest on a $100 valuation. During the past three years this Station has been experimenting with the problem of growing alfalfa on soils of this type and reference is made to some of the results in this circular.

5. Those portions of the New York hill lands very poorly underdrained and covered with wet-weather springs and spouty places can never be farmed very profitably until better underdrainage is established. The improvement usually represents a greater outlay of money than the present value of the farm. Yet it is possible to put such land into condition for growing alfalfa, and in a few years' time realize handsomely on the investment.

PREPARATION OF LAND FOR ALFALFA.

Seed-bed.— In this State, especially on the lands under discussion, alfalfa does best as a rule, when sown in the spring or early summer. The seed-bed must be compact and firm, but well pulverized on top. Alfalfa does not do well on recently plowed land unless a great amount of work is spent to compact and pulverize the soil. For this reason it is best sown on fall-plowed land or ground that can be worked into a seed-bed without spring plowing. If fall plowing is done there is no objection to using a sod and plowing may be deep. Spring plowing, if done, should be only four to six inches, and sod will not be as suitable as stubble or fallow ground. Spring-plowed land can be ready to seed by last of May to middle June. Where seeding is made in the latter part of July or early August it may follow the plowing under of a green-manure crop in early June, or may follow some crop which can be gotten off the land not later than middle July. In this latter case, as soon as the crop is off, the land should be immediately worked into a seed-bed by disking and harrowing. It should very seldom be plowed.

Application of lime.— Liming is of course one of the most essential features in preparing for alfalfa on the lands in question. Under the great majority of these conditions it is useless to attempt the growing of alfalfa until a liberal application of lime has been supplied. Two tons per acre as an initial application may be regarded as the minimum amount of limestone to use. With classes 1, 2 and 3, two to three tons per acre is usually enough to give good results, but on classes 4 and 5 at least four tons should be used; and there are indications that larger amounts would be profitable, or in some cases necessary to a successful stand of alfalfa. It is to be remembered that the alfalfa plant is unusual in its requirements for lime and that enough should be applied at the outset to insure a good supply for several years to come. For the purposes of plant food alone alfalfa uses calcium and magnesium to the equivalent of as much as one hundred pounds of limestone to each ton of cured alfalfa hay. In our experiments with alfalfa we have found ground limestone fully as effective as the best grades of hydrated lime, even for soils of the fourth class, comparisons of course being made on the basis of equal amounts of actual lime.

The best time to apply lime for any crop is to the rough surface of the ground after plowing so that it may be well mixed with the soil by disking and harrowing. On soils that require heavy applications of limestone it seems advisable to spread about half the amount before plowing and then go over the ground once or twice with a disc. This disking will also help to place the soil in good condition.

Fertilizers and manure.— With soils low in organic matter, as the great majority of these are, an application of manure is a great help in preparing a good seed-bed for alfalfa. It should be applied on the surface in the winter or early spring and worked into the soil by the fitting. With soils of classes 3, 4 and 5 it is doubtful if there is any other place in general farming where manure can be used with greater profit. The use of manure as a top dressing after a good stand of alfalfa has been secured is not so profitable, and where the amount of this material is limited it would better be used on other crops. The advantage of manure at the outset is probably to encourage inoculation and supply available plant food while the young plants are developing a root. Later, with inoculation well established and the plant drawing nitrogen from the air, manure is less important. Acid phosphate, basic slag or bonemeal make a much more profitable top dressing, using 100 to 300 pounds per acre.

In preparing the seed-bed liberal use should be made of some form of phosphorus, as acid phosphate at 500 to 1000 pounds per acre. It is not important to use commercial nitrogen and potash in addition. This has been found true at the Ohio station on soils similar to those of our class 4, and our experiments so far have worked out in the same way. The importance of phosphorus, however, has been very apparent.

Inoculation.— There is a large amount of experimental evidence both from this State and elsewhere to show that land not naturally adapted to alfalfa usually requires special inoculation as one of the important conditions to success with that crop. It has also been well demonstrated that the surest way to make the inoculation is by use of soil from some field that has been growing alfalfa successfully. Simply scatter a few hundred pounds of the soil per acre just previous to seeding the alfalfa; it should be immediately harrowed in for the sun's rays are said to kill the bacteria in a thin surface layer of soil. Two or three hundred pounds of soil per acre will do the work if thoroughly scattered, but in practice it will be found easier and safer to use a much larger quantity, provided only that the soil can be easily obtained. Soil that has been growing sweet clover will do as well for this purpose, for the bacteria of these two crops are found to be interchangeable. In obtaining the soil the surface layer to a depth of four to six inches can be used.

Artificial cultures of bacteria for inoculating the seed have been found effective and can be used instead of alfalfa soil when it is difficult to obtain the latter. Such cultures can be obtained from one of a number of commercial companies whose advertisements are to be found in farm papers. After a field has once grown alfalfa it is unnecessary to inoculate again, even though several years of other crops may intervene before reseeding to this crop.

Some farmers make a practice of mixing in a little alfalfa seed whenever seeding down to grass so that the little scattering of alfalfa that comes will gradually inoculate the soil and have it ready for a regular crop at some future time. Just how effective is this method is not definitely known.

SEEDING ALFALFA.

Time of seeding.— In this State, on the kind of land in question, spring or early summer seeding is to be preferred to sowing in middle or late summer. The most important reason is that the new plants must have time to develop a root that will see them through the first winter. With the exception of the most southeastern portion of the State seeding later than the middle of August is almost sure to result in failure or a very weak stand; the latter part of July is as late as advisable. Alfalfa seeded early in the spring has a good chance to compete with weeds, for alfalfa will grow in the cool weather of spring before most of the rank-growing weeds get a good start; and if the land has been fall-plowed many of the weed seeds will have been killed in the surface layer of soil. If seeding is delayed until corn-planting time, weeds will be a serious menace. It is then better to keep the harrow going and wait until middle June before sowing. Just how early in the spring it is advisable to seed is still a question; some men of wide experience say the very first day the land can be worked, and we are becoming inclined to this view, or, we might say, about the time of early seeding of oats. We have had some good results by sowing from first to middle June, the land having been frequently worked up to that time.

The advice is often given to cultivate the ground two or three months before sowing in order to get rid of weeds, but this is very expensive and does not always accomplish what it is supposed to do. It is always well to select land as free as possible of weeds and especially avoid such pests as quack grass. Then if seeding be made early weeds are not a serious matter. They can be kept in check by a few clippings with the cutter bar set high.

Alfalfa has the best chance for success on these soils when seeded alone. An intended nurse crop too often proves a robber crop. If the alfalfa is seeded early there will usually be a cutting of a ton to a ton and a half per acre the first season. This is worth as much for feed as any nurse crop that might have been grown, and the crop it is desired to get established will be in better condition.

When alfalfa has once been grown on any given field it can thereafter be seeded with a grain crop more successfully than at first, and when it is to occupy a place in a 3- to 5-year rotation it will usually be necessary to seed in this way. Under such conditions the grain should be sown a little lighter than common to give alfalfa a good chance.

Rate of seeding.— If seventy-five per ct. of the seed would make plants, ten pounds per acre would be a great plenty. But to allow for insufficient and improper covering of the seed and also to obtain a thick stand which will more effectively combat weeds while the plants are young, a much heavier seeding is usually made in practice. With a fine, well pulverized seed-bed and the seed all nicely covered, fifteen to twenty pounds per acre is sufficient. When these conditions are less well approximated twenty to twenty-five pounds may be used; in extreme cases even more.

Drilling is probably better than broadcasting since the seed is thus uniformly covered. Special alfalfa drills are made. If the common grain drill is used there should be a connection between the grass-seeder attachment and the hoes, and there should be arrangement for regulating the depth at which the seed is covered. It would be well to drill half the seed one way and the rest at right angles.

Types of alfalfa.— Common alfalfa seed produced in almost any part of the United States does very well in this State when grown under favorable conditions; but for the soils here considered, and especially for those of classes 4 and 5, better results are obtained from seed produced in the northern part of the country, particularly the Dakotas, Minnesota and Montana. Alfalfa from this source withstands the winter better.

The great trouble in getting alfalfa to stick on most of these soils is that it will heave out of the ground, due to alternate freezing

A.—TWO TONS OF ALFALFA HAY PER ACRE AT FIRST CUTTING ONE YEAR FROM DATE OF SEEDING.

Experimental field on farm of Hon. B. L. Winters, hill land of Tioga County, soils of class 4. This crop failed later in the summer, apparently due to an insufficient amount of lime.

B.—ONE OF THIS STATION'S EXPERIMENTAL ALFALFA FIELDS ON THE HILLS OF SCHUYLER COUNTY.

Farm of Messrs. Bolt & Huey. Seeded summer 1912; yield of two cuttings, season 1914, 3.2 tons per acre. Soils of class 4.

PLATE VIII

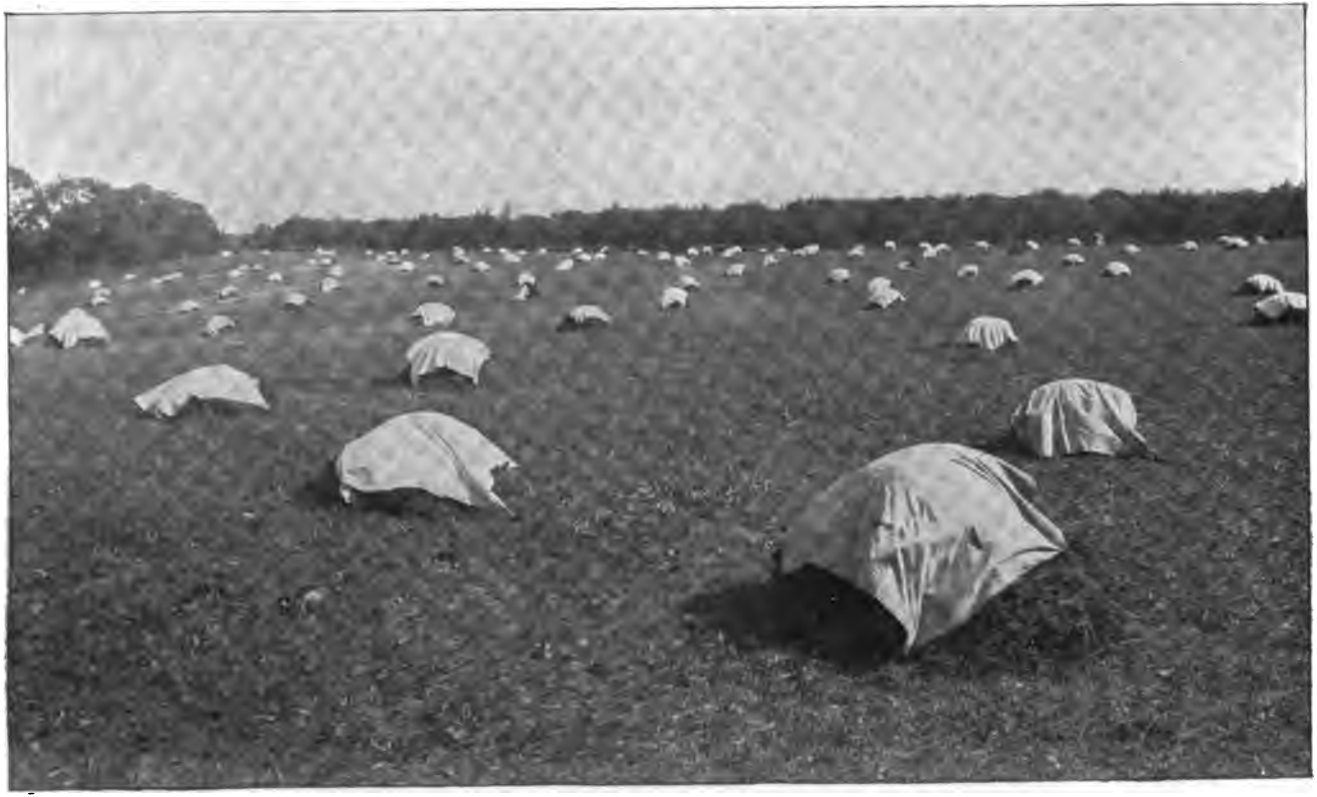

PLATE IX.— THIRD CUTTING OF ALFALFA ON FARM OF WRIGHT BROS., NEAR WESTFIELD, N. Y.

and thawing in winter and early spring. The straight, single, tap root which the common alfalfa produces offers but little resistance to this heaving action. A variety of alfalfa known as the Grimm, named from the man who first brought it over from Germany in 1857, has a vigorous branching root and stooling crown; it is also more resistant to cold. These characteristics make such a type much more promising for those conditions in this State less favorable to alfalfa. Seed from the Grimm and from the Baltic, a closely related type, are now on the market in limited quantity and at high price. To what extent and under what conditions these and other varieties and strains are better than the common varieties is being made the subject of experiment by this Station. There is such a variation in different types of alfalfa adapting that crop to so many different conditions and purposes that the opportunities for experimental work in this line are many.

Alfalfa seed production.— It has been commonly supposed that alfalfa seed could not be grown in paying quantities in this climate; and it is definitely known that a somewhat dry climate, especially at the time of seed formation, is more favorable to the production of alfalfa seed. Nearly all the seed grown in the United States is produced under semi-arid or nearly semi-arid conditions. However, nearly all the attempts to grow seed in this part of the country have in the past been with the common varieties of alfalfa. In the last few years certain farmers in this State have produced good crops of seed from some of the hardier types of alfalfa grown in a small way. Last year a small plat of Grimm alfalfa at the Station produced a heavy yield of seed from the first crop and experiments are now being conducted more extensively on this subject.

As in the case of almost any other crop, seed production in alfalfa is favored by a large development of individual plants. To accomplish this to best advantage the alfalfa is grown in cultivated rows two to three feet apart, and the plants need not be more than two or three per foot in the row. Even at this thin seeding the plants will be found to make such development that the tops reach from row to row and present the appearance of a broadcast seeding. In one of our experiments on a soil of class 4, Grimm alfalfa in rows three feet apart yielded a little over two tons of cured hay per acre at one cutting a year from date of seeding.

CUTTING AND CURING ALFALFA.

Time of cutting.— Alfalfa should be cut when new shoots begin to form at the base. This usually takes place about the same time that blossoms begin to form. In practice it does very well to go according to the blossom and to cut as soon as perhaps one-tenth of the plants have formed flowers. The first cutting of a new seeding may stand longer than this, but as a rule it is more objectional to delay cutting a little too long than to cut too soon. A delay in cutting means waste with that crop by loss of leaves from the lower part of the stem and it also means a loss of growing time for following crops, so that a delay of a week after time to cut may mean a loss of nearly two weeks' growth. This is an important matter in a climate where the growing season must often be crowded a little to get in three crops. Then, too, if cutting is delayed very long the new shoots at the base may have grown enough to be clipped by the mower and so the next crop receive a further setback.

Curing alfalfa.— Alfalfa should be cut when the dew is off and raked up as soon as wilted and before the leaves have become dry and brittle. The problem of curing is, of course, more difficult than with most grasses, for the stems are heavy and require some time to dry out, while the leaves, if dried in the hot sun, are easily shattered and also lose somewhat in quality. The hay may cure mainly in windrows if there is little danger of rain, but ordinarily it is best to put in cocks at once and cover with canvas. It may then be turned from day to day until ready for the mow. If put away too green not only is the quality of the hay impaired, but there is real danger of spontaneous combustion.

Importance of alfalfa crop.— When we consider that well-cured alfalfa hay has a protein content and total feeding value very nearly the same as that of wheat bran, or that a ton is worth as much for feed as forty to fifty bushels of oats the great advantage of this crop, especially on dairy farms, is readily understood.

Outside limestone regions the average dairy ration is probably often deficient in lime salts, so important in milk production. Alfalfa supplies lime liberally and this may help to explain the common observation that alfalfa seems to have a feeding value even greater than indicated by the percentages of protein, carbohydrates and fat. As a constituent of the dairy ration alfalfa is even more appreciated in those sections of the State where it has been considered impracticable to grow it than where it is naturally adapted, and for that reason alone it is worth a greater effort to grow it there.

If grown to sell alfalfa compares favorably with any other general farm crop. In this State it now sells at a higher price than best timothy hay, at least $15 per ton. Where it can be made to grow at all, three tons of cured hay per acre for the season is only a moderate yield.

The value of alfalfa as a builder of soil fertility adds tremendous interest to the problem of growing it on the less productive lands of the State. It will do more than clover towards adding organic matter and nitrogen to the soil and at the same time produce a much more valuable crop. One of the greatest difficulties met with in farming soils of classes 4 and 5 is the presence of a more or less impervious substratum at a depth of six inches to two and one-half feet, which is often called hard pan; although it seldom deserves so hard a name as that. This condition, though naturally present in these lands to some extent, has been aggravated the longer the land has been farmed, due to the growing of shallow-rooted crops and plowing at a shallow depth. Since alfalfa roots tend to penetrate and break up this substratum and so improve underdrainage it will no doubt be easier to grow that crop each successive time it is tried, and in this way also prove of wonderful benefit to such land.

It is best to grow alfalfa in a rotation with other crops, for in this way it is most effectively used as a soil improver. To this end the rotation may be only three or four years, including alfalfa two years and one or two years of corn, potatoes, wheat, beans, cabbage or almost any general farm crop.

SOYBEAN AND COWPEA.*

F. H. HALL.

These forage and green-manuring crops are of much greater value in states south of New York than in it; but may occasionally be used to advantage in our agriculture.

When first brought to the attention of growers in the north, the cowpea seemed promising, but in recent years the soybean has proved much better adapted to our conditions. It is more resistant than the cowpea both to frost and to drouth; all of its varieties in common cultivation are upright in growth, while the best varieties of the cowpea are viny and trailing in habit, therefore difficult to harvest for any purpose; the soybean is more certain to mature seed than the cowpea, and the yield is much greater and richer in protein. The soybean, in some of its varieties and for some purposes, may be worth trial in almost any section of the State; and is quite likely to do fairly well in all but most unfavorable seasons, when corn would fail because of late starting, long-continued cool summer weather or early death by frost. The cowpea, on the other hand, can be recommended only for light, warm soils in the southern or south-central valleys or flat lands of the State.

General character.— The soybean and cowpea are of East Asian origin, the cowpea probably from India and the soybean from China or southern Japan; but both have been cultivated so long that it is impossible to say with certainty where either grew wild. They are legumes, producing forage much higher in protein content than any other annual crop of equal yield; both are readily eaten by farm animals, either green, ensiled or made into hay; and both enrich the soil since they procure part of their nitrogen from the air and leave a considerable portion of it on the land in roots, stubble and fallen leaves. The seeds of both, but particularly of the soybean, are rich in nitrogen, and make most valuable additions to the home-grown concentrates for balancing the ordinary carbohydrate-rich rations.

The soybean plant, in general appearance and in habit of growth, resembles a tall-growing, bushy, hairy-leaved, hairy-stemmed field bean; but the pods, which are also hairy, are short and broad and usually contain only two or three beans. The seeds are shorter and rounder in shape than field beans, and show in but few varieties the typical kidney shape of beans. Most of them resemble peas more than beans; and the seeds of the cowpea resemble beans more than peas. Soybeans are smooth, or very slightly wrinkled; and in color range from a creamy white to yellow, brown or a deep violet commonly called black. The color is solid or marked with a small area of a contrasting shade about the eye.

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* A reprint of Circular No. 45, December 20, 1915.

It is difficult to see why the cowpea ever received its name; for it resembles the pea in very few respects. The vines and foliage are much more like those of lima beans, including both bush and trailing forms; but the pods are very long and slender. The seeds vary exceedingly in size and color, and in shape, as already stated, resemble beans more than do soybean seeds. In a few varieties — the "Crowders" — the seeds are compressed endwise so that they are spherical, cubical or even broader than long; but many sorts show the typical kidney shape of white beans, though usually of a somewhat wider, plumper type. They have the same colors as soybeans, with pink, red and chocolate, also, as solid colors, and with many types of eye-markings and variegations. In size, cowpea seeds vary from those smaller than wheat kernels to others larger than white beans. This great variation in size makes it very difficult to give general rules for quantity of seed to sow; since a quart of Small Lady cowpeas would contain probably six times as many seeds as a quart of Large Black-Eye, yet the plants of the two varieties require about the same area.

Uses and value.— The two crops are very similar in season, adaptability to different soils, general cultural requirements and uses; and probably under the best conditions for each the yields would not be greatly unlike, either in amount or yield of protein, but there is just enough difference between the two to secure some favor for the soybean in New York while the cowpea is very seldom grown. In states lying south of the Ohio River line, and to some extent north of that river, the cowpea can be grown with corn, the vines clinging to the stalks and finding the season warm enough and long enough to mature seed just as the corn ripens, so that the double crop can be easily harvested and cut into the silo, making a feed of great value. In New York, sunlight and heat are not great enough to make this combination a success; and only on exceptionally warm soils or in long, warm seasons does the soybean-in-corn combination give satisfactory yields. Yet the two crops, grown separately and cut into the silo together, or with the soybeans replacing every third row of corn and harvested together for ensiling, have given very good results in several places. This is undoubtedly the most promising field of usefulness for the soybean in the State, although it can also be utilized to advantage in a soiling system, or grown for the seed. For making into hay, the slenderer, less woody vines of the cowpea are preferable; but the yield is usually not great enough to make the crop a successful competitor of alfalfa or even of the clovers, while curing the hay in the fall is often a difficult problem because of bad weather. This objection also applies to the making of soybean hay, with the added disadvantage that the stalks and larger branches of the soybean become fibrous and woody as the plants approach the best period of yield, so the time for making good hay is rather short.

It is very doubtful whether it is ever wise to turn down the entire crop of either legume for green manure, the wiser plan being to leave the refuse only on the land, feed the crop, and return the manure to the field.

Yields and feeding value.— On the Station soil, which is heavy and cold, we have never secured satisfactory crops of seed from any variety of soybean, even in the long, hot, season of 1914; and only a few of the very early, bushy, small-yielding varieties of cowpeas have matured seed. However, on lighter, warmer soils near the Station, several varieties of soybeans have matured, but exact yields can not be stated. In tests in Connecticut in 1914, nine varieties of soybeans with medium-sized to large seed averaged 28 bushels of beans to the acre. This is probably much above the average yield, though as much as 34 bushels to the acre have been grown in Massachusetts. From 12 to 20 bushels is given as the average range of yields. As stated, these seeds are very rich in protein, equalling or exceeding cottonseed meal or linseed meal in the amount that can be digested by animals, of this most important constituent of feeds.

Of forage to cut into the silo, of which none has borne fully developed pods, the Station yields have varied from 6 to 10 tons to the acre with soybean, which compare favorably with yields reported from Massachusetts and Connecticut and with averages for the soybean-growing states; and of from 5½ to 9 tons with cowpea, on small areas only, which are only about three-fourths as large as the yields secured in states further south.

Like the seeds, soybean forage contains much protein, particularly when harvested with the pods nearly or quite full grown, reaching 4 per ct. or more with a moisture content of 75 per ct. in the green crop. This makes it equivalent to almost as much alfalfa in feeding value, and superior to as much red clover.

Cowpea forage usually contains more moisture than that from soybean and a smaller percentage of protein in the dry matter of the plant, so that, even with equal yields, it would not have equal value with soybean forage.

Some figures are given below showing the feeding value of the two crops, compared with a few other common feeding stuffs. The comparisons are based on the quantity of each material digested by cattle, not on the chemical composition alone:

ASH AND DIGESTIBLE NUTRIENTS IN SOYBEAN AND COWPEA SEEDS AND FORAGE; AND IN SOME COMMON FEEDING STUFFS.

(Figures mainly from Henry and Morrison's "Feeds and Feeding.")

FEED.	Ash.	Digestible		
		Protein.	Carbohydrates.	Fat.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*
Soybean seeds *	5.4	31.7	22.8	14.4
Cowpea seeds	3.4	19.4	54.5	1.1
Wheat bran	6.3	12.5	41.6	3.0
Linseed meal, n. p.	5.6	31.7	37.9	2.8
Cottonseed meal, prime	6.6	33.4	24.3	7.9
Soybean hay	8.6	11.7	39.2	1.2
Cowpea hay	11.9	13.1	33.7	1.0
Alfalfa hay	8.6	10.6	39.0	0.9
Red clover hay	7.1	7.6	39.3	1.8
Soybean forage, green *	2.5	3.5	10.6	0.6
Cowpea forage, green	2.0	2.3	8.0	0.3
Alfalfa, green	2.4	3.3	10.4	0.4
Red clover, green	2.1	2.7	13.0	0.6
Corn silage	1.7	1.1	15.0	0.7
Corn and soybean silage	2.0	1.6	13.8	0.8

* Figures modified to include recent Connecticut Station analyses.

Culture.— Where these legumes are so uncommon that success with the crop is problematical, small test areas only should be first attempted. Both crops do best on light, warm, loam soils, but will succeed in favorable seasons on any reasonably good corn land. Being legumes, and therefore nitrogen-gatherers when provided with root nodules, neither soybeans nor cowpeas require much, if any, nitrogenous fertilizer, though a very light application of nitrate of soda is helpful in securing a vigorous start. Where they have never been grown, inoculation, preferably with soil from a successful field, is a great advantage; but the soybean seems to acquire the necessary bacteria, without planned introduction, much more readily than some other legumes. If, however, on carefully digging up a few plants no bacteria appear on the roots of the first season's crop, artificial inoculation should be used before seeding again.

If the test crop succeeds and the soil appears to be well inoculated, so that nitrogen enough can be secured from air and soil for maximum crops, the grower should be sure that lack of phosphoric acid or potash does not limit growth; for the plants require 2½ times as much potash and nearly two-thirds as much phosphoric acid as nitrogen for perfect development.

Liming is less necessary with soybeans than with other legumes.

The planting season with ordinary varieties coincides well with that of corn, though the seeds, particularly those of soybeans, germinate best in soil a little warmer than at corn-planting time, so sowing or planting may well be delayed a little in cold seasons. If started a week or ten days later than corn, early-maturing varieties should be in condition to go into the silo with the corn and the very early sorts be mature before frost. The young plants of soybean, if well started, will recover after a touch of frost, being better in this respect than cowpeas or even white beans.

For hay or for soiling, both soybeans and cowpeas may well be sown broadcast to secure smaller stalks and vines, which make a better grade of hay; and some of the later-maturing sorts should be selected, since these usually produce larger, more viny plants with the cowpea and taller, heavier-foliaged plants with soybean. Earlier seeding should also be planned for a hay crop than for silage. For broadcast seeding, from a bushel to a bushel and a quarter of seed is necessary, increasing the amount if the variety used is very large-seeded, decreasing it if small-seeded.

With the very viny cowpeas it is well to sow about a peck to the acre of wheat, barley or oats so that the stiff stems may partially support the vines and make harvesting less difficult. It is quite liable to be an unpleasant task at best.

If seed is scarce and high-priced, it may be better to drill in the seed, even for hay, spacing the rows far enough apart to allow cultivation, to which these crops respond readily and profitably. With cowpeas of any of the vine-producing kinds the rows should be 2½ to 3½ feet apart, while with the soybeans the distance may be 1½ to 2½ feet or more. Plants should be from 3 to 5 inches apart in the rows. The greater distances should be used if seed is to be matured and harvested, the medium distances if the forage is to be cut into the silo and the smaller distances for hay or soiling. The cultivation is about like that for corn, enough to keep down weeds and hold moisture until the plants shade the ground. In the south, where conditions are more favorable, cowpeas, and soybeans to some extent, are planted with corn, either in drills using about one-half more "peas" or "beans" than corn, or placing the seeds of the legumes in the hills of corn at planting time or beside the hills a few days later. This practice has been followed to some extent in this State, but under most conditions not even the soybean succeeds well enough in this way to make very rich silage, and cowpeas do still less.

During 1915, only, has this method of handling the crops given a satisfactory growth of soybean forage on the Station farm, and even then the seeds were far from mature. A better way is to substitute a row of soybeans for every third row of corn, by which the plants are not so shaded by the corn, give a good yield and reach approximate maturity. The combined crops can be gathered by a corn harvester without much difficulty; and, with a satisfactory development of the soybeans, makes a silage rich enough in protein to reduce largely the expense for purchased concentrates. When grown separately, one acre of well podded soybeans put in the silo with two or two and a half acres of corn should make a very rich silage.

Varieties — There are hundreds of varieties of cowpeas and many of soybeans, but only a few have proven successful enough at the north to justify recommending them. Other varieties are being developed probably better than those now generally grown; but seed of these is not generally obtainable. Among the better known reliable varieties are the following:

COWPEAS.

Clay.— An erect, late-maturing plant, producing a good growth of forage and heavy crop of seed where it matures; seeds deep brownish buff, of medium size, short, broad kidney shape.

Large Black-Eye.— Recumbent, viny, late-maturing plant, producing heavy growth of forage but not likely to mature; seeds very large, white with small black eye-spot; shape of thick, broad white bean.

New Era.— Very erect, no vines, matures early producing much seed, but little forage. Seeds very small, gray, thickly sprinkled with small blue dots, much compressed endwise.

Red Ripper.— Semi-recumbent, many vines, late, large yield of forage, does not mature. Seeds very large, brownish pink, almost cubical.

Unknown or Wonderful.— Very large and vigorous, erect, late. Much forage, does not mature. Seeds above medium size, light reddish buff, very broad, short kidney shape.

Whippoorwill.— Erect but viny, vigorous, heavy yield of forage, too late for seed in north. Seeds medium size, buff or brown mottled chocolate color, broad plump kidney shape.

SOYBEANS.

Early Green, Medium Early Green, Medium Green, properly Guelph.— Most common variety in north for growth with corn. Stout, erect, bushy; medium to heavy yield of both forage and seed, which should mature in good seasons. Pods drop seeds too readily when mature. Seeds green, medium in size or above, elliptical, slightly flattened.

Hollybrook.— Stout, erect, bushy, taller than Guelph, slightly longer season. Yield good of both forage and seeds. Does not shatter as badly as Guelph. Seeds straw yellow, small to medium in size, elliptical.

Ito San.— Plants stout, erect, bushy, rather small. Medium early, yields well. Seeds much like those of Hollybrook.

Mammoth Yellow.— Stout, erect, bushy, very tall; late, heavy yield of forage; will seldom mature seed. Seeds straw yellow, medium or below in size, elliptical, slightly flattened.

Wilson.— Slender, erect, very tall, medium late; possibly better than Guelph as it shatters little. Heavy yield of forage and good seed producer. Seeds black, medium size, elliptical, much flattened.

Among other varieties that are worth trial if seed can be easily secured are Ogemaw, Early Brown, Auburn, Elton, Chestnut, Medium Yellow, Swan, Cloud, Ebony, Haberlandt, and Peking, listed somewhat in the order of ripening.

REPORT

OF THE

Department of Bacteriology.

R. S. Breed, *Bacteriologist.*
H. J. Conn, *Associate Bacteriologist.*
G. L. A. Ruehle, *Assistant Bacteriologist.*
J. D. Brew, *Assistant Bacteriologist.*
[1] W. D. Dotterrer, *Student Assistant.*

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III. Pasteurization of dairy by-products.

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[1] Appointed March 1.

REPORT OF THE DEPARTMENT OF BACTERIOLOGY.

MILK QUALITY AS DETERMINED BY PRESENT DAIRY SCORE CARDS.*

JAMES D. BREW.

SUMMARY.

1. Dairy score cards were originally designed to instruct the dairyman and to serve as a convenient record of sanitary conditions. Their use has led to a common belief that there is a relation between the score of the dairy and the quality of the milk produced by it. Scores are even being used as the sole basis for the grading of milk according to quality.

2. The investigation reported in this bulletin was a comparative study between the bacterial content of the milk and the scores of 34 commercial dairies made on three representative cards, namely, the Cornell card, the Official card approved by the Official Dairy Instructors' Association and the New York City card. The purpose was to determine what relationship existed between the bacteria count and the score; and how different cards agreed when the same conditions were scored simultaneously by one person.

3. The results of the investigation show no correlation whatever between the quality of the milk so far as it could be determined by laboratory methods and the score as expressed by any one of these three cards.

4. Using officially accepted interpretations of each of the three score cards, it was found that there was some variation in the relative positions of the various dairies when scored simultaneously with all of the cards. In general, however, the scores secured by using the Cornell card were the most lenient, while those secured by using the New York City card were the most severe. None of the 34 dairies scored below the exclusion point on either the Cornell or Official card, while 15 dairies scored below this point on the New York City card.

INTRODUCTION.

The grading of milk according to quality, as is being done with many articles of food, is now considered essential as a means of improving city milk supplies. The earlier attempts to control milk quality were largely based upon chemical tests. The purpose of this control was to guard the public against fraud, practiced by altering the normal constituents of the milk or adding preservatives to it. Recently, however, attention has been more concerned with the qualities of milk as affected by the presence of bacteria.

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Two general types of bacteria are of interest in this connection, namely, those which do not cause disease and those which do cause disease. The first are important because large numbers of them in milk indicate that it is no longer fresh; the second, because their presence involves danger to health. The lack of satisfactory laboratory technique for the detection of the latter kinds of bacteria has caused attention to be directed largely towards keeping the total number of bacteria at a minimum in all market milk.

Early in the development of sanitary milk work, it became evident that the conditions under which the milk was produced on the farm played a large part in determining the amount of bacterial contamination. Consequently it was reasoned that the improvement of barn construction and of dairy methods would insure a safe, pure milk. As a result, all of the various factors supposed to affect milk production were incorporated in dairy score cards, the use of which appeared to be the most practical means of obtaining the desired improvement. These cards have now come into general use both by health officials and by commercial dairy companies. The various conditions or methods considered essential were allotted certain numerical ratings on these score cards, the importance and value of which were determined as well as could be done in the light of the knowledge then available.

The aim in designing the score card was to instruct the producer in the importance of cleanliness in handling milk and to designate those places where improvement could be made. At the same time the card served as a record of the sanitary conditions. There was no thought of the score being used as an index of the quality of milk produced. Of late, however, with the increasing movement in favor of grading milk according to actual quality, the score card has been drawn into use as a convenient means of determining grades of milk. This implies that there is a relationship between the quality of milk and the dairy score. Moreover, there appears to be a widespread belief that such a relationship exists.

For this reason the present investigation was undertaken to determine whether there is a correspondence between the actual quality of milk produced and the dairy score. Furthermore, since there are several such cards in use, a study has also been made to determine whether the scores secured by the use of different cards agree when the same conditions are scored on each simultaneously.

WHAT IS MEANT BY MILK QUALITY.

Before proceeding further, it is necessary to make clear what is understood when speaking of milk quality. This is not easy to define because opinions differ widely and several variable factors must be taken into consideration. For the purpose of discussion, the following definition will be used: Milk to be of high quality should (1) have a food value suited to the needs of the consumer, (2) should be free from visible dirt, unpleasant odors and tastes, (3) should not contain an excessive number of bacteria and (4) should be free from disease germs.

The difficulties which beset an investigation which attempts to compare the actual quality of milk with barn scores are at once apparent. In the first place, the actual quality of milk as defined above is difficult to determine by means of present laboratory methods. There is no way of accurately measuring such factors as odors, tastes and dirt in milk, nor (from the standpoint of routine analysis) is there any practical means of detecting the presence of disease organisms. In the second place, the chemical constituents of the milk are not mentioned on dairy score cards. This leaves only one means by which the quality of milk and the dairy score may be compared, namely, the bacteria count.

THE INVESTIGATION.

PLAN OF WORK.

For several years this Station has been investigating the relative importance of the various dairy operations or conditions specified on the score card from the sanitary standpoint. The work was originally planned by Dr. H. A. Harding, and is now being carried on in cooperation with the Illinois Agricultural Experiment Station. In this connection a comparative study of score cards was made. The purpose of this was, primarily, to determine the agreement between the final scores when the same dairy conditions were scored at the same inspection on different score cards. Many forms of cards have been devised; but it was impossible and unnecessary to make use of all in existence. Consequently three cards were selected which were unquestionably representative.

The first card chosen is the one known as the Official Score Card, because of its endorsement by the Official Dairy Instructors' Association. This has now become of greater importance in this State because of its adoption with slight modification as the official card for New York State by the State Board of Health. The second is the one in use by the New York City Board of Health; and the third was the one then in use by the Dairy Department of the Agricultural College at Cornell University. The three cards are reproduced on pages 129, 130-131, 132 respectively.

In order to conduct such a comparative study it was essential that someone become thoroughly familiar with each card and the manner of its application. This was undertaken by the author, who had already become acquainted with the Cornell card while acting as dairy inspector for the Ithaca Board of Health. To become acquainted with the other two cards necessitated spending some time with inspectors familiar with the cards in question. Nearly three weeks were spent working with inspectors for the New York City Board of Health. One week was spent with an inspector representing the Dairy Division of the Bureau of Animal Industry of the U. S. Department of Agriculture.

It must be recognized that the interpretation of the different cards is an important and varying factor. Two inspectors, working independently, do not score the same conditions exactly alike on the same card; and even the same inspector cannot score the same conditions alike at different times. In the preliminary study the aim was to learn the general interpretation of each card from persons familiar with its use and then to apply all three cards simultaneously to the same conditions with the personal element controlled by having the scoring done by one person. Every scoring was made very carefully, giving each card as nearly as possible the interpretation officially accepted, regardless of any personal opinions held by the scorer.

The interpretations of the cards given on pages 134 and 135 were found to be in use by the inspectors.

OFFICIAL SCORE CARD.

United States Department of Agriculture, Bureau of Animal Industry.

Dairy Division.

Indorsed by the Official Dairy Instructors' Association.

EQUIPMENT.	SCORE.	
	Perfect.	Allowed.
COWS.		
Health	6	
Apparently in good health 1		
If tested with tuberculin within a year and no tuberculosis is found, or if tested within six months and all reacting animals removed 5		
(If tested within a year and reacting animals are found and removed, 2.)		
Feed (clean and wholesome)	2	
Water	2	
Clean and fresh 1		
Convenient and abundant 1		
STABLES.		
Location of stable	2	
Well drained 1		
Free from contaminating surroundings 1		
Construction of stable	4	
Tight, sound floor and proper gutter 2		
Smooth, tight walls and ceiling 1		
Proper stall, tie, and manger 1		
Provision for light: Four sq. ft. of glass per cow	4	
(Three sq. ft., 3; 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.)		
Bedding	1	
Ventilation	7	
Provision for fresh air, controllable flue system 3		
(Windows hinged at bottom, 1.50; sliding windows, 1; other openings, 0.50.)		
Cubic feet of space per cow, 500 ft. 3		
(Less than 500 ft., 2; less than 400 ft., 1; less than 300 ft., 0.)		
Provision for controlling temperature 1		
UTENSILS.		
Construction and condition of utensils	1	
Water for cleaning	1	
(Clean, convenient, and abundant.)		
Small-top milking pail	3	
Facilities for steam	1	
(Hot water, 0.50.)		
(In milk house, not in kitchen.)		
Milk cooler	1	
Clean milking suits	1	
MILK ROOM OR MILK HOUSE.		
Location: free from contaminating surroundings	1	
Construction of milk room	2	
Floor, walls, and ceiling 1		
Light, ventilation, screens 1		
Separate rooms for washing utensils and handling milk	1	
Total	40	

METHODS.	SCORE.	
	Perfect.	Allowed.
COWS.		
Cleanliness of cows	8	
(Free from coarse dirt, 6.)		
STABLES.		
Cleanliness of stables	6	
Floor 2		
Walls 1		
Ceiling and ledges 1		
Mangers and partitions 1		
Windows 1		
Stable air at milking time	6	
Freedom from dust 3		
Freedom from odors 2		
Cleanliness of bedding 1		
Barnyard	2	
Clean 1		
Well drained 1		
Removal of manure daily to field or proper pit	2	
(To 50 feet from stable, 1.)		
MILK ROOM OR MILK HOUSE.		
Cleanliness of milk room	3	
UTENSILS AND MILKING.		
Care and cleanliness of utensils	8	
Thoroughly washed 2		
Sterilized in live steam for 15 minutes 5		
(Placed over steam jet, or scalded with boiling water, 2.)		
Inverted in pure air 1		
Cleanliness of milking	9	
Clean, dry hands 3		
Udders washed and dried 6		
(Udders cleaned with moist cloth, 4; cleaned with dry cloth or brush at least 15 minutes before milking, 1.)		
HANDLING THE MILK.		
Cleanliness of attendants in milk room	2	
Milk removed immediately from stable without pouring from pail	2	
Cooled immediately after milking each cow	2	
Cooled below 50° F.	5	
(51° to 55°, 4; 56° to 60°, 2.)		
Stored below 50° F.	3	
(51° to 55°, 2; 56° to 60°, 1.)		
(If delivered twice a day, allow perfect score.)		
Transportation below 50° F.	2	
(51° to 55°, 1.50; 56° to 60°, 1.)		
Total	60	

Equipment .... + **Methods** .... = ... **Final Score.**

NOTE 1.—If any exceptionally filthy condition is found, particularly dirty utensils, the total score may be further limited.

NOTE 2.—If the water is exposed to dangerous contamination, or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

ORIGINAL.

Equipment 40% Score.............. %
Methods 60% Score.............. %
Perfect Dairy 100% Score.............. %

DEPARTMENT OF HEALTH.

THE CITY OF NEW YORK.

Division of Milk Inspection. **Dairy Report.**

Inspection No.................Time...............A. P. M. Date....................191....
1 **Dairyman**.................................... **Owner**....................................
2 **P. O. Address**.................................... **P. O. Address**..............State..............
3 **County**..................State.............. **Party Interviewed**..............................
4 Milk delivered to Creamery at..Formerly at..............
5 Operated by..Address..............................
6 Distance of farm from Creamery..............................Occupied farm since..............
7 No. Cows..................No. Milking..................No. Qts. Produced..............
8 All persons in the households of those engaged in producing or handling milk are.............. free from all infectious disease. Weekly reports are..............being filed..............
9 Date and nature of last case on farm..
10 WATER SUPPLY for utensils is from a..................located..................feet deep and apparently is..............pure and wholesome.............................. State any possible contamination located within 200 feet of source of water supply or if water supply is not protected against surface drainage..
....
....
11 Water supply on this farm analyzed..............................191...... Result..............
12 Style of Cow Barn..............Length..............ft. Width..............ft. Height of ceiling..............ft.
13 **Dairy Rules** of the Department of Health are..............................posted..............
14 **Dairy Herd** examined by..............................on..................191...... Report..............

	Perfect.	Allow.
EQUIPMENT		
15 **COW STABLE** is..............located on elevated ground with no stagnant water, hog-pen, privy, uncovered cesspool or manure pit within 100 feet....	1	....
16 **FLOORS**, other than cow beds, are..............of concrete or some non-absorbent material..............................	2	....
17 Floors are..............properly graded and water-tight..............	2	....
18 Cow beds are..............of concrete or planks laid on concrete..............	2	....
19 **DROPS** are..............constructed of concrete, stone or some non-absorbent material..............................	2	....
20 Drops are..............water-tight and space beneath is clean and dry..............	2	....
21 **CEILING** is constructed of..............and is..............tight and dust proof....	2	....
22 **WINDOWS** No..............total square feet..............there is..............2 square feet of window light for each 600 cu. ft. air space (1 sq. ft. per each 600 cu. ft.— 1)..............................	2	....
23 **VENTILATION** consists of..............sq. ft. muslin covered openings or ....sq. ft. open chutes in ceiling or.............................. ....which is sufficient 3, fair 2, poor 1, insufficient 0....	3	....
24 **AIR SPACE** is..............cu. ft. per cow (600 and over—3) (500 to 600—2) (400 to 500—1) (under 400—0)..............................	3	....
25 **LIVE STOCK**, other than cows, are..............excluded from rooms in which milch cows are kept..............................	2	....
26 There is..............direct opening from stable into silo or grain pit..............	1	....
27 Separate quarters are..............provided for cows when calving or sick..............	1	....
28 **COW YARD** is..............properly graded and drained..............................	2	....
29 **WATER SUPPLY** for cows is..............unpolluted and plentiful..............	1	....

	Perfect.	Allow.
30 **MILK HOUSE** has..........direct opening into cow barn or other building..	1	
31 Milk house has..........sufficient light and ventilation..........	1	
32 Floor is..........properly graded and water-tight..........	1	
33 Milk house is..........properly screened to exclude flies..........	1	
34 Milk pails are..........of smoothly tinned metal in good repair..........	1	
35 **MILK PAILS** have..........all seams soldered flush..........	2	
36 Milk pails are..........of the small-mouthed design, top opening not exceeding 8 inches in diameter. Diameter..........	2	
37 Racks are..........provided to hold milk pails and cans when not in use....	2	
38 Special milking suits are..........provided..........	1	
	40	
METHODS		
39 **STABLE INTERIOR** painted or whitewashed on..........which is satisfactory 3, fair 2, unsatisfactory 1, never 0..........	3	
40 **FEEDING TROUGHS**, platforms or cribs are..........well lighted and clean	1	
41 Ceiling is..........free from hanging straw, dirt or cobwebs..........	3	
42 Window panes are..........washed and kept clean..........	1	
43 **WALLS AND LEDGES** are..........free from dirt, dust, manure or cobwebs	2	
44 **FLOORS AND PREMISES** are..........free from dirt, rubbish or decayed animal or vegetable matter..........	2	
45 **COW BEDS** are..........clean, dry and no horse manure used thereon..........	2	
46 Manure is..........removed to field daily 4, to at least 100 feet from barn 2, stored less than 100 feet or where cows can get at it 0..........	4	
47 Liquid matter is..........allowed to saturate ground under or around cow barn	2	
48 Milking stools are..........clean..........	1	
49 Cow Yard is..........clean and free from manure..........	2	
50 **COWS** have..........been tuberculin tested and all tuberculous cows removed	7	
51 Cows are..........all in good flesh and condition at time of inspection..........	2	
52 Cows are..........all free from clinging manure and dirt. (No. dirty..........)	4	
53 **LONG HAIRS** are..........kept short on belly, flanks, udder and tail..........	1	
54 **UDDER AND TEATS** of cows are..........thoroughly brushed and wiped with a clean damp cloth before milking..........	3	
55 **ALL FEED** is..........of good quality and distillery waste or any substance in a state of putrefaction is..........fed..........	2	
56 **MILKING** is..........done with dry hands..........	2	
57 **FORE MILK** or first few streams from each teat is..........discarded..........	2	
58 Clothing of milkers is..........clean..........	1	
59 Facilities for washing hands of milkers are..........provided in cow barn or milk house..........	2	
60 Milk is strained at..........and..........in clean atmosphere..........	1	
61 Milk is..........cooled within two hours after milking to 50 degrees F. 3, to 55 degrees F. 2, to 60 degrees F. 1..........	3	
62 Ice is..........used for cooling milk..........	1	
63 **MILK HOUSE** is..........free from dirt, rubbish and all material not used in the handling and storage of milk..........	1	
64 Milk utensils are..........rinsed with cold water immediately after using and washed clean with hot water and washing solution..........	2	
65 Utensils are..........sterilized by steam or boiling water after each using....	2	
66 Privy is..........in sanitary condition, with vault and seats..........covered and protected..........	1	
	60	

Remarks..........

Duplicate Score Received

.... Dairyman. .... Inspector of Foods.

Cornell Score Card for Production of Sanitary Milk.

Date.................. Dairy of.................................... P. O....................................

Retailed by..

		Perfect Score.	Cuts.
I. HEALTH OF THE HERD AND ITS PROTECTION.	Health and comfort of the cows and their isolation when sick or at calving time..	45	....
	Location, lighting and ventilation of the stable........................	35	....
	Food and water......................	20	....
	Total..........................	100	
II. CLEANLINESS OF THE COWS AND THEIR SURROUNDINGS.	Cows..............................	30	....
	Stable............................	20	....
	Barnyard and pasture.................	20	....
	Stable air (freedom from dust and odors).	30	....
	Total..........................	100	
III. CONSTRUCTION AND CARE OF UTENSILS.	Construction of utensils and their cleaning and sterilizing.......................	40	....
	Water supply for cleaning and location and protection of its source..........	25	....
	Care of utensils after cleaning..........	20	....
	Use of small-top milking pail...........	15	....
	Total..........................	100	
IV. HEALTH OF EMPLOYEES AND MANNER OF MILKING.	Health of employees..................	45	....
	Clean over-all milking suits and milking with clean, dry hands...............	30	....
	Quiet milking, attention to cleanliness of the udder and discarding the foremilk..	25	....
	Total..........................	100	
V. HANDLING THE MILK.	Prompt and efficient cooling............	35	....
	Handling milk in a sanitary room and holding it at a low temperature...........	35	....
	Protection during transportation to market	30	....
	Total..........................	100	
	TOTAL OF ALL SCORES........	500	

If the total of all scores is	And each division is	The sanitary conditions are
480 or above	90 or above	EXCELLENT
450 or above	80 or above	GOOD
400 or above	60 or above	MEDIUM
Below 400	Or any division is below 60	POOR

The sanitary conditions are.............................. Scored by..

SCORE CARD CUTS USED ON CORNELL CARD.*

HEALTH OF HERD AND ITS PROTECTION.

No tuberculin test, 12.
Old tuberculin test (over one year), 12.
Rigid stanchions (not cut when cows were confined only during milking, as in summer), 3.
Light, 1 to 5, according to conditions.
No special system of ventilation, 2.
Ventilation 1 to 5.
No comfortable provision for isolation or calving outside of stable containing milking cows, 5.
Stable poorly built to protect from the weather, 1 to 5.

CLEANLINESS OF COWS AND THEIR SURROUNDINGS

Manure or dust on cows, 1 to 10.
Hair about udders not clipped, 1.
Damp cloth not used on udders before milking, 2
Litter or roughage on stable floor, 1 to 5.
Ceiling not tight, 1 to 5.
Cobwebs and dust in stable, 1 to 5.
Stable not whitewashed within one year, 5.
Horse in cow stable, 5.
Manure not removed once per day, 1 to 10.
Manure or mud in barnyard to which cows have access, 1 to 10.
Feeding dry feed just before milking, 1 to 10.
Objectionable odors in stable, 1 to 5.

CONSTRUCTION AND CARE OF UTENSILS

Insufficient cleaning, 1 to 5.
No special sterilization (no steam), 5.
No small-topped pail, 15.

HEALTH OF EMPLOYEES AND MANNER OF MILKING

No special clean milking suits, 5.
Dirty suits, 1 to 5.
Milking with wet hands, 10.
Unclean hands, 1 to 6.

HANDLING THE MILK.

Not efficiently cooled (50° F. or below).
  50° to 60°, cut 5.
  61° to 70°, 10.
  above 71°, 15.
Not held at 50° F. or below, 5.
Milk strained in stable, 5.
Milk room not clean, 1 to 5.
No milk room, 3.

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* These were the cuts as applied to actual conditions. More unsanitary surroundings would merit greater cuts than those indicated.

New York City card.— In rating the various requirements on this card, full credit was allowed any condition or method which was considered perfect, but if imperfect in any way it was given zero. No attempt was made to divide any of the points according to actual conditions, except as specified on the card itself.

Official card.—Each individual requirement on this card was allowed due credit according to its actual condition or degree of compliance, so far as possible. In other words, the aim was to recognize even slight changes in sanitary conditions since the previous inspection. All ratings were made upon a percentage basis, determined by the judgment of the inspector. Take, for instance, the question of the cleanliness of the ceiling which was scored 1 point by the inspector if perfect. If the ceiling was not clean the inspector would take into account the cobwebs, straws, etc., and might conclude that the ceiling was 25 per ct. dirty. He would then deduct 25 per ct. from 100 per ct. and write the score down as .75. Strictly speaking this method of deduction is equivalent to scoring on the basis of 10,000 and therefore requires an impossible mathematical accuracy, especially when dealing with such intangible and unmeasurable factors as are found on all dairy score cards. Exceptions were made in a few instances where the cuts were specified, and in a few others such as " Food " and " Water " where full credit was allowed in all ordinary cases.

Cornell card.— The system of cuts used with this card was flexible, although fairly well standardized (see page 133).

In actual practice it is possible to subject any of the cards to widely different interpretations. In fact, one instance is known where the Official card is interpreted in a way quite similar to that described under the New York City card. The three cards were used in this investigation according to the interpretations just described.

An examination of the cards reveals the fact that each is made out on a somewhat different basis; although there is a marked similarity between the Official and New York City cards. On both, a perfect score is rated 100 per ct. of which 40 per ct. is allowed for equipment and 60 per ct. for methods. These two cards, however, differ considerably in treatment of various barn conditions or methods. For instance the New York City card places much emphasis upon the necessity of a concrete or other non-absorbent floor (10 points in all) while the Official card simply requires a tight, sound floor with proper gutter (2 points in all) and makes no reference to the material used for construction. There are several other instances where differences occur, one of the most important of which is that the Official card devotes 16 points to the handling of the milk immediately after it is drawn from the cow while the New York City card devotes but 5 points to the same thing.

The numerical basis of the Cornell card is entirely different from that of the other two cards. Dairy operations or conditions are classified under five headings with a perfect score of 100 for each, making a total score of 500. The barns are then classed as "Excellent," "Good," Medium" or "Poor," according to their score.

Since this work was completed the following changes have been made in the Official card. The item "Food (clean and wholesome)" has been reduced from 2 points to 1 point for a perfect score. The item with reference to water has been changed to read "Water (clean and fresh)" allowing 1 point in place of 2, for a perfect score. The number of points allowed for the use of small-top pails has been increased from 3 points to 5 points. Under the subdivision "Utensils" the item "Facilities for steam 1 point (Hot water 0.5)" has been transferred to subdivision "Milk room or milk house."

The present study of dairy scores as compared with the quality of milk was made on the milk supply of a New York State city of about 14,000 people. The milk was produced from about forty farms. Nearly all of the farmers were grain and fruit growers and regarded the dairy as a minor source of income. For several years, the local health board had been exercising supervision over the sanitary conditions and consequently the dairymen were accustomed to inspection and score-card requirements. With the exception of two independent milkmen all of the milk was distributed by two retail companies to whom the producers delivered their milk each morning in 40-quart cans washed by the respective companies.

After becoming familiar with the application of each card the dairies studied were given three scorings at different times. In connection with the third scoring, a comparison was made between the bacteria counts and the barn scores. This was done during July and August of 1913.

BACTERIOLOGICAL EXAMINATIONS.

Methods of sampling.— Separate samples of night milk and morning milk from each producer were taken daily for one week directly from the can as it was placed upon the milk station platform. If a producer had several cans, a composite sample was taken from all of the cans containing milk of the same age. The milk in each can to be sampled was first stirred with a long-handled dipper by means of which a sample was transferred to a sterile pint milk bottle. At no time was night milk less than twelve nor more than fifteen hours old when delivered, while morning milk was never more than four hours old.

Plating.— The samples were taken at once to the laboratory and plated in lactose agar made according to the following formula:

Liebig's beef extract	5 grams
Witte's peptone	10 "
Agar	15 "
Lactose	10 "
Distilled water	1,000 c. c.

The acidity was determined and adjusted so that at no time was it less than 1.3 per ct. nor more than 1.5 per ct. normal acid to phenolphthalein. The plates were prepared in duplicate using two dilutions; and the period of incubation was 5 days at 21° C. (70° F.). Counting was done with the aid of a hand lens.

The milk from thirty-four producers was plated. Two of these used ice in cooling, while the remainder either used an aerator with running water or placed the cans in vats of water. The cooling was applied chiefly to night milk and nearly all of the morning milk was still warm when delivered. Thus the factors of age and temperature were fairly well known and are comparable. The temperature of practically all of the morning milk was above 68° F., while that of night milk ranged between 55° and 66° F.

In addition to the bacteria counts of the milk a sediment test was made for the insoluble dirt. This was done by filtering each pint of milk through a cotton disk after the sample had been taken for plating. Since no means was at hand for measuring and expressing the visible dirt, quantitatively, these results were left out of consideration. So far as could be observed, however, there was no relation between the amount of dirt visible on the cotton disk and the barn score. Some of the cleanest milk came from the lowest scoring barns.

EXPERIMENTAL DATA.

This discussion will be facilitated if the quality of milk is considered in the light of the bacterial requirements for the grades of milk established by the New York City Board of Health regulations and by the State Sanitary Code.[1] The bacterial requirements by New York City are as follows for each grade.

Grade A milk raw shall not at any time previous to delivery to the consumer contain more than 60,000 bacteria per cubic centimeter.

Grade A milk pasteurized shall not contain, previous to pasteurization, more than 200,000 bacteria per cubic centimeter; nor more than 30,000 after pasteurization.

Grade B milk must be pasteurized and shall not average, previous to pasteurization, more than 300,000 bacteria per cubic centimeter if pasteurized outside of the city; but if pasteurized within the city the maximum average allowed is 1,500,000 bacteria per cubic centimeter. After pasteurization it shall not contain more than 100,000 bacteria per cubic centimeter.

Grade C milk must be pasteurized and must not be sold if it contains more than 300,000 bacteria per cubic centimeter after pasteurization.

Where the bacterial standards are used for the grades of milk established by the State Code they are quite similar to those established by the New York City regulations. The requirements for Grade A milk raw and pasteurized are identical. Provision is made, however, for Grade B raw, the requirements being that this grade of milk shall not contain more than 200,000 bacteria per cubic centimeter at any time previous to delivery to the consumer. The requirements for Grade B milk pasteurized are similar to those for New York City except that nothing is said in regard to pasteurizing milk within a city and the bacterial requirement is so worded that no milk containing more than 300,000 bacteria per cubic centimeter can be pasteurized and sold as Grade B. This is a more stringent requirement than the New York City requirement. The State Code makes provision for both Grade C raw and Grade C pasteurized but places no limits upon the bacterial content of either. Both health departments exclude all milk which is produced in dairies that score below 40 points.

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[1] The Sanitary Code established by the Public Health Council of the State of New York, Chapter III Milk and Cream. Nov. 16, 1914. Issued by the New York State Department of Health, Albany, N. Y.

A COMPARATIVE STUDY BETWEEN THE BARN SCORES AND THE BACTERIA COUNTS OF THE MILK.

Table I contains a summary of the results obtained from each of the farms studied in this investigation. The results are arranged with reference to the bacteria count of night milk, placing the lowest first. The scores made simultaneously with the three cards are placed opposite each count.

TABLE I.— A COMPARISON BETWEEN THE BACTERIA COUNT OF NIGHT MILK AND THE DAIRY SCORES OF THIRTY-FOUR FARMS.

Farm number.	Plate count per c. c.		New York City score.		Official score.		Cornell score.
	P. M. milk.	A. M. milk.	Total.	Methods.	Total	Methods.	Total.
1	7,580	13,000	34	20	56.90	36.35	430 M*
2	54,000	57,000	43	28	53.65	36.50	446 M
3	98,000	....	41	25	54.90	35.20	432 M
4	102,000	29,000	45	25	56.60	33.90	439 M
5	118,000	52,000	36	21	49.00	28.45	428 M
6	138,000	21,000	36	22	53.85	33.85	437 M
7	148,000	34,000	49	26	49.45	29.15	433 M
8	162,000	18,000	28	15	51.35	31.55	430 M
9	267,000	99,000	35	21	56.30	34.40	433 M
10	300,000	....	31	19	45.95	29.10	401 M
11	313,000	....	53	24	57.20	36.35	432 M
12	380,000	....	39	22	54.15	31.75	416 M
13	537,000	907,000	57	30	55.70	31.90	442 M
14	538,000	165,000	35	18	50.10	32.15	422 M
15	570,000	610,000	45	22	48.70	29.05	435 M
16	687,000	58,000	73	41	73.08	38.63	469 G
17	732,000	....	38	20	50.45	29.25	436 M
18	762,000	320,000	58	29	66.10	37.20	455 G
19	777,000	13,000	47	29	58.65	34.10	450 G
20	812,000	67,000	53	29	57.35	34.40	442 M
21	937,000	153,000	40	22	50.05	28.65	429 M
22	1,442,000	....	50	29	49.75	27.75	413 M
23	1,758,000	45,000	39	23	54.95	32.05	447 M
24	1,758,000	103,000	35	23	49.65	32.15	439 M
25	2,700,000	....	55	24	64.25	30.60	451 G
26	2,909,000	1,282,000	40	20	55.40	31.65	430 M
27	3,056,000	....	27	14	59.00	37.45	439 M
28	3,158,000	88,000	40	27	55.90	31.15	433 M
29	3,167,000	....	50	30	58.75	29.70	451 G
30	4,180,000	....	86	50	79.40	43.35	481 E
31	4,215,000	....	42	18	48.95	28.10	417 M
32	5,239,000	163,000	36	22	57.80	39.00	428 M
33	13,356,000	3,219,000	38	23	49.85	30.20	436 M
34	57,820,000	1,284,000	38	25	53.60	29.80	433 M

* E = Excellent, G = Good, M = Medium. See page 135.

The lack of relationship between the quality of milk as expressed by the bacteria count and the conditions surrounding its production as expressed by the barn score is the most striking thing noticed in a study of this table. Apparently no correlation exists between the bacteria count and the barn score as expressed by any one of the cards. In this particular series of analysis, all of the dairies with high scores produced milk with relatively high bacteria counts, while the best quality of milk from a bacterial point of view was produced in low-scoring barns.

Both the State Sanitary Code and the New York City Regulations specify in their requirements for Grade A and Grade B milk that a dairy must score at least a certain percentage in equipment and a certain percentage in methods. These two percentages, when added together, make the total minimum score required for each grade. It is possible for a dairy to be deficient in one of these and at the same time be nearly ideal in the other. In fact, it frequently happens that the excess in one sufficiently overbalances the deficiency in the other to cause the total score of the dairy to be high enough to meet the requirements for the next higher grade. Yet owing to the deficiency in methods or equipment the milk is placed in the lower grade. This condition actually happened in sixteen cases among those dairies scoring 55 per ct. and above. The deficiency, in every case but one, was in methods. On this account an objection may be raised to comparing the score of these dairies to the bacteria count of the milk produced, on the ground that, if these dairymen had improved their methods the bacteria count might have been lowered; a possibility which must be admitted.

It is usually thought that the methods employed in dairies are of greater importance in determining the bacteria quality of the milk than the equipment, yet if the bacteria count of the milk produced on the farms studied is compared to the score of methods alone (See Table I, columns 2, 5 and 7) it will be seen that the same lack of relationship exists as when the bacteria counts are compared with the total scores. For instance Farms 16 and 30 score considerably higher in methods than do any of the other farms, yet the milk produced from these two farms is markedly inferior to that produced from the first eight farms. According to the New York City card, the methods employed by twenty-eight dairy farms range in score between twenty and thirty points. Thus, so far as the score is concerned, the methods of these farms vary but little while there is a great variation in the bacterial condition of the milk produced. A similar condition holds in regard to the scores for methods on the Official card.

A similar comparison can be made in Table III (Columns 2, 3 and 5) between the bacteria count for morning milk and the score for methods. Since this milk was only a few hours old when examined the question of bacterial growth due to age and insufficient cooling is less important, and a relationship would be shown if any were present. Since there is no evident relationship even in this case for either the Official or New York City cards it must be concluded that none exists.

There are four barns among the first eight in Table I which score below 40 per ct. (the point of exclusion) on the New York City card yet from which a milk is produced which could be pasteurized as Grade A milk so far as bacterial requirements are concerned. The milk from twenty-six of these dairies ranged in bacteria count from 267,000 to 57,820,000 per cubic centimeter. Of these, eleven score below 40 per ct. on the New York City card and would therefore be excluded from selling milk in that city. This leaves sixteen farms which would be allowed to sell milk so far as score is concerned. Among these are all of the dairies with high scores, several of which produced milk with higher bacteria counts than did some of the excluded dairies. If the score by the Official card were accepted as a basis none of the dairies would be excluded. There still exists, however, the same lack of correlation between the bacteria count and the scores as in the case of the New York City card. This same statement likewise applies to the Cornell card. In this series, high counts occur in milk produced in dairies rating as " Excellent," " Good " or " Medium " while the low count milk all comes from " Medium " dairies.

Farm 1 presents an interesting case. According to the New York City score this producer would be excluded. If the quality of milk were to be determined by the score alone it would be rated as distinctly bad. On the contrary, however, extensive bacteriological examinations of the milk from this farm show that such care was used in handling of the milk that it was invariably of excellent quality. During the months of April and May of the same year (1913) 23 samples of night milk gave an average plate count of 9,950 per cubic centimeter — the highest being 34,000; while 23 samples of morning milk averaged 16,000 per cubic centimeter — the highest being 67,000. The low count obtained in the protracted study of the milk from this particular farm together with the low counts obtained in both morning and night milk from the first eight farms (Table I) clearly indicate that these farmers were consistent in observing care with regard to those factors most liable to produce a high bacteria count in the milk. In view of the high bacteria counts in milk produced in the high-scoring barns, it is evident that, if these factors are all included in the present score cards, then they either cannot be expressed mathematically or else they have not been given their correct mathematical value.

TABLE II.—SCORES ON LOW-SCORING AND HIGH-SCORING DAIRIES.

FARM 1.

Card used.	Date of inspection.	Scores for equipment.	Scores for methods.	Total scores.
New York City Card...........	Nov. 21, 1912	11	18	29
	Jan. 28, 1913	12	20	32
	July 10, 1913	14	20	34
	Oct. 23, 1913	14	18	32
Official Card..................	Nov. 21, 1912	19.90	29.00	48.90
	Jan. 28, 1913	18.95	30.90	49.90
	July 10, 1913	20.55	36.35	56.90
	Oct. 23, 1913	20.90	29.40	50.30
Score required to produce Grade C milk............................				40

FARM 30.

Card used.	Date of inspection.	Scores for equipment.	Scores for methods.	Total scores.
New York City Card...........	Dec. 3, 1912	30	52	82
	Feb. 6, 1913	29	50	79
	July —, 1913	36	50	86
Official Card..................	Dec. 3, 1912	33.90	42.70	76.60
	Feb. 6, 1913	34.45	46.45	80.90
	July —, 1913	36.05	43.35	79.40
Score required to produce Grade A raw milk.....		25	50	75

As will be seen, Farm 30 has a high bacteria count while the score entitles it to produce Grade A milk. Bacteriological examinations of the milk from this farm show comparatively wide fluctuations. One series of ten morning milk samples, taken during the fall of 1912 gave an average plate count of 207,000 per cubic centimeter — the lowest being 55,000 and the highest 466,000. Another series of twelve night milk samples, taken in November, 1914, averaged 33,000 per cubic centimeter — the lowest being 5,200 and the highest 87,000. The factors which caused these variations are difficult to determine. Bacterially this milk fluctuated from Grade A raw to Grade C during the period of investigation. In this connection, it should be noticed that the scores made on Farms 1 and 30 did not change appreciably in inspections made at different times as shown in Table II.

According to the Cornell card, Farm 1 scored 416, 418, 430 and 434 and Farm 30–482, 482 and 481, respectively, the former being in the " Medium " class and the latter in the " Excellent " class.

Some may contend that it is unfair to compare the bacterial content of night milk and the barn score on the ground that the age of the milk and varying temperatures to which it had been subjected had had such a marked influence on the growth of bacteria that any possible relationship between score and bacteria count would have been completely obscured. This objection is offset to a considerable degree in a comparison which has been made between the score on the three cards and the bacteria count of morning milk reported upon in Table III. As previously stated, none of the morning milk was older than four hours at the time of delivery; and in only one case did the temperature average less than 68° F., while the highest was 77° F. Therefore these two factors were fairly well controlled or were, at least, of much less importance than in the night milk. There is little doubt but that the bacteria count under these conditions more truly indicates the initial contamination.

According to Table I, the milk of but two dairies qualifies bacterially as Grade A raw, while eight could qualify for the production of Grade A pasteurized. In Table III, however, the milk from ten farms could qualify as Grade A raw and seventeen as Grade A pasteurized. Among these seventeen, it will be noticed from Table I that there are several which had high bacteria counts in night milk. For instance Farms 23, 24, 28 and 32 gave bacterial counts above 1,000,000 per cubic centimeter in night milk. When this fact is considered in connection with the three series of counts made on Farm 30 (see page 123) it is clear that none of the scores keep pace with the wide fluctuations in bacteria counts.

TABLE III.— A COMPARISON BETWEEN THE BACTERIA COUNT OF MORNING MILK AND THE DAIRY SCORES OF TWENTY-THREE FARMS.

Farm number.	Plate count per c. c. A. M. milk.	New York City score.		Official score.		Cornell score.
		Total.	Methods.	Total.	Methods.	Total.
1..........	13,000	34	20	56.90	36.35	430 M[*]
19..........	13,000	47	29	58.65	34.10	450 G
8..........	18,000	28	15	51.35	31.55	430 M
6..........	21,000	36	22	53.85	33.85	437 M
4..........	29,000	45	25	56.60	33.90	439 M
7..........	34,000	49	26	49.45	29.15	433 M
23..........	45,000	39	29	54.95	27.75	447 M
5..........	52,000	36	21	49.00	28.45	428 M
2..........	57,000	43	28	53.65	36.50	446 M
16..........	58,000	73	41	73.08	38.63	469 G
20..........	67,000	53	29	57.35	34.40	442 M
28..........	88,000	40	27	55.90	31.15	433 M
9..........	99,000	35	21	56.30	34.40	433 M
24..........	103,000	35	23	49.65	32.15	439 M
21..........	153,000	40	22	50.05	28.65	429 M
32..........	163,000	36	22	57.80	39.00	428 M
14..........	165,000	35	18	50.10	32.15	422 M
18..........	320,000	58	29	66.10	37.20	455 G
15..........	610,000	45	22	48.70	29.05	435 M
13..........	907,000	57	30	54.70	31.90	442 M
26..........	1,282,000	40	20	55.40	31.65	430 M
34..........	1,284,000	38	25	53.60	29.80	433 M
33..........	3,219,000	38	23	49.85	30.20	436 M

[*] E = Excellent, G = Good, M = Medium. See page 135.

The lack of relationship between the bacteria counts and the scores is brought out more clearly in Table IV. Here the scores on each card are arranged separately and in order, beginning with the highest. This also shows how the three score cards compare when applied to the same dairies.

From this table, it is clearly seen that it is impossible to tell from which barn the best quality of milk is produced by means of any of these score cards. While bacteria counts do not have a direct relation to the presence or absence of disease germs, yet, within certain limits, they do indicate the care the milk has received. In so far as care tends to eliminate the dangers from communicable diseases, it cannot be justly claimed that the milk from the high scoring barns is safer than the milk from such barns as the first eight in Table I.

TABLE IV.— DAIRY SCORES OF THIRTY-FOUR FARMS ARRANGED IN ORDER WITH THE CORRESPONDING BACTERIA COUNT OF NIGHT MILK OPPOSITE.

NEW YORK CITY CARD.			OFFICIAL DAIRY CARD.			CORNELL CARD.			
Farm No.	Score.	Plate count per c.c.	Farm No.	Score.	Plate count per c.c.	Farm No.	Score.	Scores in per ct.	Plate count per c.c.
30	86	4,180,000	30	79.40	4,180,000	30	481 E*	88.6	4,180,000
16	73	687,000	16	73.08	687,000	16	469 G	81.4	687,000
18	58	762,000	18	66.10	762,000	18	455 G	73.0	762,000
13	57	537,000	25	64.25	2,700,000	25	451 G	70.6	2,700,000
25	55	2,700,000	27	59.00	3,056,000	29	451 G	70.6	3,167,000
20	53	812,000	29	58.75	3,167,000	19	450 G	70.0	777,000
11	53	313,000	19	58.65	777,000	22	447 M	68.2	1,758,000
29	50	3,167,000	32	57.80	5,239,000	2	446 M	67.6	54,000
23	50	1,442,000	20	57.35	812,000	13	442 M	65.2	537,000
7	49	148,000	11	57.20	313,000	20	442 M	65.2	812,000
19	47	777,000	1	56.90	7,580	4	439 M	63.4	102,000
4	45	102,000	4	56.60	102,000	24	439 M	63.4	1,758,000
15	45	570,000	9	56.30	267,000	27	439 M	63.4	3,056,000
2	43	54,000	28	55.90	3,158,000	6	437 M	62.2	138,000
31	42	4,215,000	26	55.40	2,909,000	17	436 M	61.6	732,000
3	41	98,000	22	54.95	1,758,000	33	436 M	61.6	13,356,000
28	40	3,158,000	3	54.90	98,000	15	435 M	61.0	570,000
26	40	2,909,000	13	54.70	537,000	7	433 M	59.8	148,000
21	40	937,000	12	54.15	380,000	28	433 M	59.8	3,158,000
22	39	1,758,000	6	53.85	138,000	34	433 M	59.8	57,820,000
12	39	380,000	2	53.65	54,000	9	433 M	59.8	267,000
34	38	57,820,000	34	53.60	57,820,000	11	432 M	59.2	313,000
17	38	732,000	8	51.35	162,000	3	432 M	59.2	98,000
33	38	13,356,000	17	50.45	732,000	26	430 M	58.0	2,909,000
32	36	5,239,000	14	50.10	538,000	1	430 M	58.0	7,580
6	36	138,000	21	50.05	937,000	8	430 M	58.0	162,000
5	36	118,000	33	49.85	13,356,000	21	429 M	57.4	937,000
9	35	267,000	23	49.75	1,442,000	32	428 M	56.8	5,239,000
14	35	538,000	24	49.65	1,758,000	5	428 M	56.8	118,000
24	35	1,758,000	7	49.45	148,000	14	422 M	53.2	538,000
1	34	7,580	5	49.00	118,000	31	417 M	53.2	4,215,000
10	31	300,000	31	48.95	4,215,000	12	416 M	49.6	380,000
8	28	162,000	15	48.70	570,000	23	413 M	47.8	1,442,000
27	27	3,056,000	10	45.95	300,000	10	401 M	40.6	300,000

* E — Excellent, G — Good, M — Medium. See page 135.

A COMPARATIVE STUDY OF THE SCORES OBTAINED BY THE THREE CARDS.

It is not the purpose to take up in this bulletin a detailed consideration of the dairy operations or conditions specified on the score cards and compare the cards in this way. A comparison has been made merely between the final scores obtained.

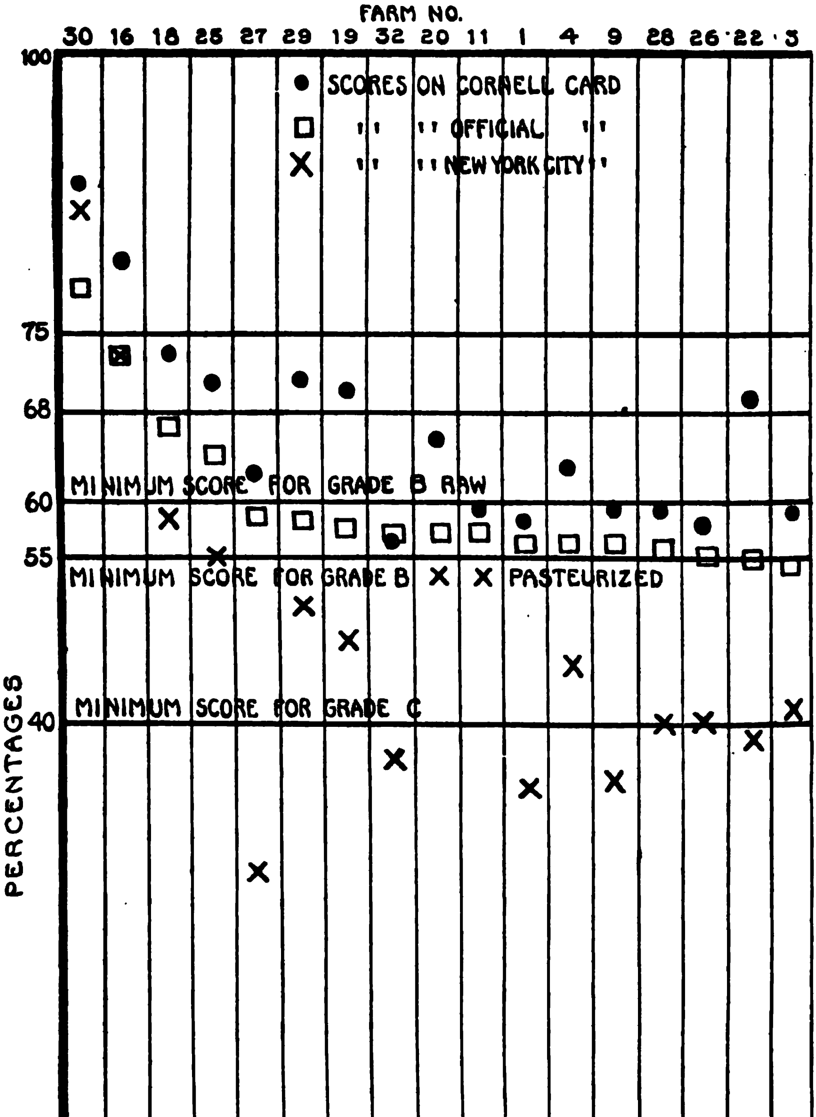
The Official card and the New York City card are very similiar in their general plan. In fact, each card scores on the basis of 100 per ct., and in this respect they are identical. The Cornell card, however, is drawn up on an entirely different plan and, in order to compare, it was therefore essential to reduce the rating of the card to a percentage basis.

When this is done it will be seen that 400, which is the dividing line between "Medium" and "Poor" dairies, equals 80 per ct. In other words a dairy must stand at least 80 per ct. to pass, while 40 per ct. is the passing mark established in the regulations of both the New York State Board of Health and the New York City Board of Health. Because of this wide difference in the exclusion points it was necessary to still further transform each Cornell score in order to make the basis of scoring the same as that of the other two cards. In Table IV each Cornell score is thus transformed (Column 9).

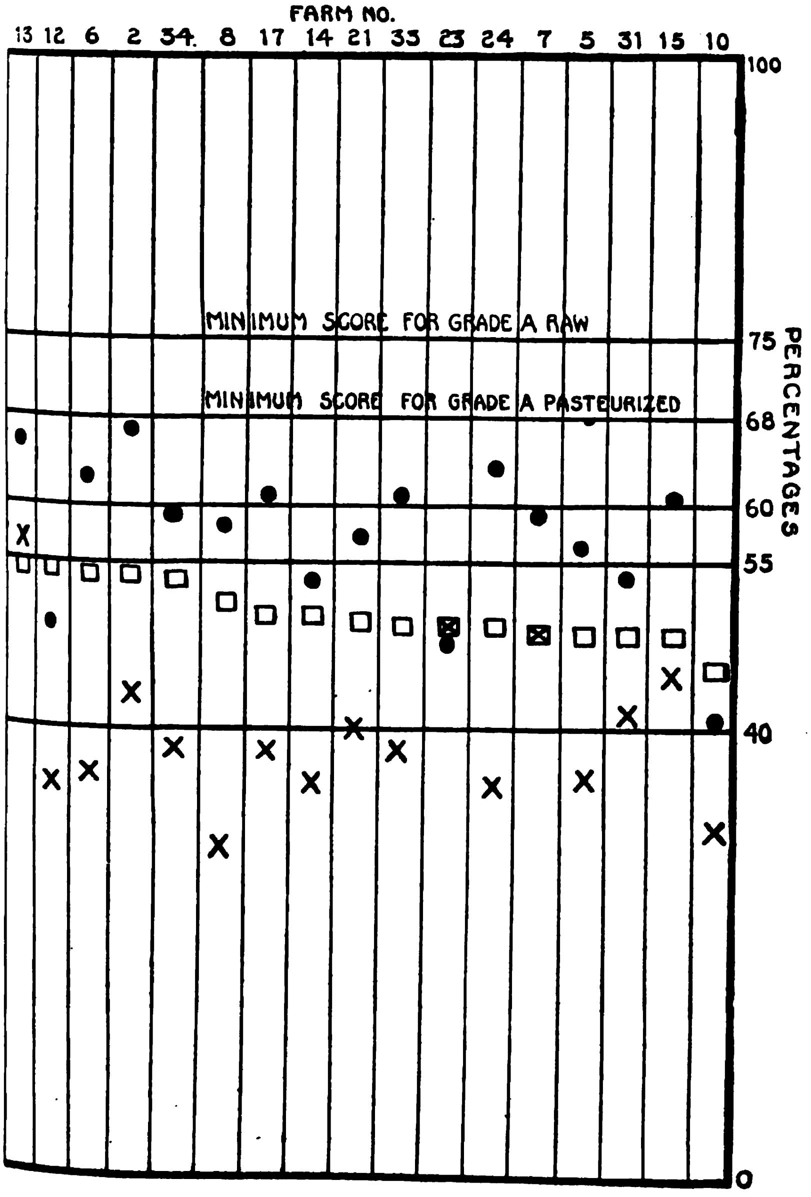
The actual comparison between the three cards is shown more clearly in Graph 1 (pages 128 and 129). The horizontal lines in this graph represent the minimum scores for each grade of milk established by the regulations of both the New York State Board of Health and the New York City Board of Health. The spaces between the vertical lines represent each dairy scored. The numbers of the dairies as given in Table I are placed at the top of the graph. The scores are shown graphically as follows: solid black dot indicates score on Cornell card, hollow square the score on Official card and the cross the score on the New York City card. The scores are arranged with reference to those obtained on the Official card.

It is evident from this graph that the Cornell card is the most lenient. This is shown by the fact that of the 34 dairies, the total scores of 29 were high enough to entitle them to produce Grade A or B milk, while according to the scores on the Official card only 16 dairies were entitled to this privilege and only 5 according to the scores on the New York City card. The Cornell card rates only 5 dairies as Grade C, while 18 are thus rated on the Official card and 14 on the New York City card. None of the dairies scored below the exclusion point on either the Cornell or the Official card, while 15 dairies scored below this point on the New York City card.

It is further evident that there is little agreement between the scores obtained by the three cards when applied to the same conditions. This, of course, is largely affected by the different interpretations used. In this investigation, however, there was an agreement among the three cards as to the three dairies which would be considered the best from the standpoint of scores. These dairies also occupied the same relative position on each card. Beyond this there were instances of wide variations. The scores obtained by



GRAPH I.—COMPARATIVE SCORES OF THIRTY-FOUR



Dairies by Three Score-card Systems of Rating.

the Official card and the Cornell card agreed as to the poorest scoring dairy, while there was a slight variation in the rating of this particular dairy on the New York City card. As will be seen from the graph, however, the variations between the scores on the Official card and the Cornell card are not so great as between the New York City card and either of the other two. The greatest variation found is in the case of Farm 27 which scores at the foot of the list on the New York City card but scores 32 points higher on the Official card, rating fifth from the top, while the score on the Cornell card is 5.4 points higher than that of the Official card and is 37.4 points higher than the New York City card, and rates thirteenth from the top.

It should be kept in mind that these comparative scores are discussed in this paper with reference to the interpretation gained by the author while working with inspectors trained in the application of the respective cards. Since different interpretations exist, it is quite probable that other systems of cuts than those used would give somewhat different results. It may be that both the New York City and Official cards could be so interpreted that the results secured would compare closely. This tendency to vary the interpretations put upon the cards is one of the weaknesses of all of the present score cards as a means of grading milk, which has been generally recognized.

CONCLUSIONS.

The originators of the present score cards evidently had two purposes in mind, first that the cards should act as guides in instructing the producers in the importance of cleanliness in the handling of milk, and second that they should serve as records of the sanitary conditions. The use of these cards has caused a widespread belief to grow up that there is a correlation between the actual quality of the milk and the score of the barn conditions. This belief is undoubtedly becoming more firmly fixed in the mind of the general public and will undoubtedly become more so as a result of the rules and regulations governing the grading of milk and cream in this State, issued by the Public Health Council. According to these regulations local health officials are allowed a choice; that is, they may grade milk and cream by means of bacteria counts and dairy scores combined, or they may do the grading by means of the dairy scores alone. The second choice, under which no Grade A milk can be placed on the market, implies a relationship between the quality of the milk and the score which is not borne out by the present investigation.

In so far as the quality of milk can be determined by present laboratory methods, there exists no relationship between the quality of milk and the dairy score on the score cards now in use. Milk of all grades, ranging from the finest quality to the poorest, is produced in barns which would be excluded on account of low scores. All grades of milk are likewise produced in the high-scoring barns.

The real explanation for this lack of relationship between the scores and the bacteria counts cannot be given as yet with absolute certainty. The most apparent reason, as shown by investigations made at this Station, is that a large number of the items included on the score card have little or no effect upon the number of bacteria present in the milk. In other words, too great emphasis is placed upon unessential factors in all of the score cards studied, with a consequent lessened emphasis upon the factors which actually do affect the milk.

Some may contend that these findings encourage the production of milk under filthy conditions. This contention will be raised only by those who hold the idea that low-scoring dairies are necessarily unsanitary and filthy. Such conditions have, however, not been found to hold true in the region studied because low-scoring dairies were found which vied in cleanliness with the most ideal of the high-scoring dairies. On the contrary, however, these facts give decided encouragement to the intelligent dairyman who finds that he can produce high-grade milk by the simple observation of the few essential factors of cleanliness and care. This places him in a position to secure a greater profit from his business while at the same time he has the moral satisfaction of knowing that he is selling a high-grade article. Where the present score cards are used, all dairies, in order to get credit for Grade A milk, are forced to an additional expense and consequently to an increased cost of production. At the same time a compliance with the score-card requirements carries with it no guarantee that the quality of milk will be improved or rendered more safe from the standpoint of public health.

The fact that high-grade milk can be produced with simple equipment, likewise gives encouragement to the consumer who is as much interested in keeping down the cost of producing high-grade milk as is the producer.

None of the results secured in this investigation can be so construed as to disprove the value of dairy score cards, but they do show that present score cards cannot be satisfactorily used as a means of grading milk according to quality. There is little hope of designing a score card which will accomplish this purpose until all of the factors which are thought to affect the quality of milk in any way have been carefully studied; and the influence of each determined and accurately measured. In this way the really important factors can be singled out and given the proper values on the score card.

ACKNOWLEDGMENTS.

The author wishes to express his sincere appreciation to Dr. Robert S. Breed, Bacteriologist of this Station, for his criticisms of the manuscript; also to Dr. H. A. Harding, formerly Bacteriologist of this Station, for assistance given in suggesting and directing the original plan for the study of the score card.

Acknowledgments are likewise due the New York City Board of Health and those in charge of the market milk investigations of the Bureau of Animal Industry of the U. S. Department of Agriculture for assistance rendered in the preliminary study of the use and application of the respective cards.

GERM CONTENT OF STABLE AIR AND ITS EFFECT UPON THE GERM CONTENT OF MILK. *

G. L. A. RUEHLE AND W. L. KULP.

SUMMARY.

PART I.

1. Comparable results can be obtained in quantitative bacterial air analyses by the use of aeroscopes in which either fine sand or liquid filters are used provided they are handled in a careful manner. A modified form of the Standard aeroscope (sand filter) has been found to be the most convenient to use in routine work.

2. Very irregular percentages were secured in efficiency tests when the Standard aeroscopes were used because their construction necessitates steam sterilization. Such sterilization causes the sand filter to cake, leaving lanes or pores through which bacteria may pass. The modified form of aeroscope which has been devised is so constructed as to permit dry sterilization. Percentage efficiency tests of this form of aeroscope showed that the filter in this aeroscope probably retains all of the bacteria.

3. Equally good percentage efficiency tests were obtained with the Rettger aeroscope (liquid filter) but it was found that very careful manipulation was necessary to secure the best results and that this instrument was not as usable for routine work as was the modified form of the Standard aeroscope.

4. The method of determining the amount of bacterial precipitation from the air by means of exposed petri plates has been found to be entirely unreliable as a means of measuring the number of bacteria. This method gives the number of bacteria-laden dust particles rather than the number of bacteria present. The number of bacteria precipitating upon a given area has been determined in this investigation by analysing measured quantities of sterile water which had been exposed to the air for a known length of time in sterile pails. The numbers so obtained were from two to thirty-two times as great as those obtained by the plate-exposure method.

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* A reprint of Bulletin No. 409, August, 1915.

PART II.

5. When the cattle were in the Station stable, the germ content of the air in the stable was usually between 50 and 100 per liter. The maximum count was 825 per liter. Sterile water "milked" from a specially devised apparatus under these conditions had an average germ content of 12 per cubic centimeter. The highest count obtained was 73 per cubic centimeter.

6. In the stable loft, when a heavy dust was raised by sweeping up the debris on the floor at the beginning of each test, the germ content of the air was usually between 1,000 and 2,000 per liter. In the same way when the dust was maintained continuously throughout each test, the greater number of the results were between 2,500 and 10,000 per liter. Sterile water "milked" under these dusty conditions had an average germ content of 47.6 per cubic centimeter when the dust was raised but once for each test and 604 per cubic centimeter when the dust was maintained continuously during each test.

7. Fifty-eight analyses of the air in three commercial dairies gave numbers similar to those obtained in the Station stable in all but four analyses. These were taken under dusty conditions and gave results similar to those obtained in the stable loft.

8. When a sterile fluid was exposed for five minutes to the air of the Station stable, an average of 55 colonies developed for each square centimeter of surface when chopped dry hay was being fed, 71 when dry grain was fed and 114 when milking was in progress. Under the same conditions, if a five-liter (about five quarts) pail of milk were exposed in an open 12-inch pail for one hour, the germ content added to the milk would have been 99, 124 and 199 respectively.

9. When the heavy dust was raised in the stable loft, the average number of colonies which developed per square centimeter after a five-minute exposure was 678 in that series of tests where the dust was raised but once for each test. In the series of tests where the dust was stirred up continuously, the similar number was 28,377. The germ content of a pail of milk exposed to such heavily contaminated air would be increased by one to several thousand bacteria per cubic centimeter in a few minutes exposure.

GENERAL INTRODUCTION.

Modern dairy practice is subject to many regulations designed to prevent the germs in the stable air from coming into contact with the milk. This is the direct result of early ideas concerning the relation of bacteria to the dust particles in the air. Since it is evident, even to the casual observer, that relatively large amounts of dust are frequently present in stable air at milking time, it is easy to understand why these regulations have been formulated. No one, however, seems to have succeeded in demonstrating exactly how many bacteria are added to milk from the dust in the air. The conclusions that have thus far been reached have usually been based on data gathered indirectly and the investigators who have done this work have been almost unanimously of the opinion that the stable air is a significant source of the bacterial contamination of the milk.

The present study was undertaken in order to obtain more direct data upon the subject. The investigation forms part of a larger problem which has been the subject of investigation at the Station for a number of years and which is now being completed in cooperation with the Illinois Agricultural Experiment Station. Briefly stated, this problem is a study of the relative importance of various barn operations as sources of contamination in the production of sanitary milk. The work already reported will be found in Bulletins Nos. 317, 326 and 365 and in Technical Bulletin No. 27.[1]

ACKNOWLEDGMENTS.

Credit is due Dr. H. A. Harding [2] for having suggested the original plan of the work upon the germ content of barn air and for valuable aid in carrying out the first part of it. The work was completed under the direction of Dr. Robert S. Breed. Dr. John Weinzirl, member of the Committee on Standard Methods for the Examination

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[1] Harding, H. A., Wilson, J. K., and Smith, G. A. Milking machines: Effect of method of handling on the germ content of the milk. N. Y. Agr. Exp. Sta., Bul. 317, 1909.

Harding, H. A., Wilson, J. K., and Smith, G. A. The modern milk pail. N. Y. Agr. Exp. Sta., Bul. 326, 1910.

Harding, H. A., Ruehle, G. L., Wilson, J. K., and Smith, G. A. The effect of certain dairy operations upon the germ content of the milk. N. Y. Agr. Exp. Sta., Bul. 365, 1913.

Harding, H. A., and Wilson, J. K. A study of the udder flora of cows. N. Y. Agr. Exp. Sta., Tech. Bul. 27, 1913.

[2] Formerly Bacteriologist at this Station.

of Air, appointed by the American Public Health Association, has also given several helpful suggestions during the course of the work reported in Part I. Mr. G. A. Smith had charge of the dairy herd and barn during the time that this work was being done and has contributed materially to the success of the work. Mr. W. D. Dotterrer aided in taking the samples recorded in Table XII. The authors wish to express their gratitude to these men for the aid thus given.

The data recorded in the Bulletin were gathered by a division of labor between the authors. Mr. Kulp did the analytical work recorded in Tables II, VII, VIII, IX, X, XI, and part of that recorded in Table XVII. Mr. Ruehle made the remainder of the analyses and prepared the results for publication.

PART I. METHODS OF BACTERIAL ANALYSIS OF AIR.

Before the main problem could be attacked, it was necessary to test the prevailing methods of bacterial air analysis. All of the methods in use at the time when this problem was undertaken (June, 1912) seemed open to criticism. Two methods of analysis were in favor at that time; the sand filtration method modeled after Petri[3] and the bubbling method recommended by Rettger.[4] Comparative tests of these two methods are described in Part I. During the course of the work a modification of the apparatus used in the sand filtration method was devised and this modification was tested in comparison with the two methods just mentioned. In addition to this study of methods of determining the number of bacteria in a given volume of air, studies were also made of the technique which has been used for determining the number of bacteria precipitating upon a given area in a given time.

PREVIOUS STUDIES.

Only a very brief historical review of the literature dealing with the technique of sampling the air for bacteria will be given here because it has already been presented more fully in a paper in the *Journal of Agricultural Research.*[5] As is well known, our first methods of bacterial analyses of air were devised by Pasteur in connection with his efforts to disprove the theory of spontaneous generation. He used both soluble and insoluble granular solids as filtering agents, such as guncotton and asbestos, but mostly for qualitative results. In his later work he used the vacuum flask method of analysis for rough quantitative work. This method was further developed by Hansen.[6]

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[3] Petri, R. J., Eine neue Methode Bacterien und Pilzsporen in der Luft nachzuweisen und zu zählen. *Ztschr. Hyg.*, 3: 1–145, 1888.

[4] Rettger, L. F. A new and improved method of enumerating air bacteria. *Jour. Med. Research*, N. S. 17: 461–468, 1910.

[5] Ruehle, G. L. A. Methods of bacterial analyses of air. *Jour. Agr. Research*, 4: 343–368. 1915.

Miquel[7] also used several methods of analysis among which was the method of bubbling the air through a liquid in an apparatus which he called an aeroscope.

Petri[8] first used fine sand as a filtering agent, and his method of analysis, with slight modifications, has been in use ever since. In his method the sand which contains the ensnared micro-organisms was mixed directly with the nutrient medium.

Sopor[9] washed the sand in sterile water and made his plates from measured portions of the wash water. In this way he obtained more transparent plates and probably a more thorough admixture of the bacteria and the medium than had previous investigators.

Rettger[10] has modified Miquel's aeroscope by drawing the air through a device which insures better contact between the air and the filtering liquid. This will be more fully described later in connection with the present studies.

Weinzirl and Fos[11] were among the first investigators to use a very fine sand of standard size. Their work forms the chief basis for the recommendation of the sand filtration method by the Committee on Standard Methods for the Examination of Air.[12] In 1912 a sub-committee [13] gave a report of progress in which they recommended certain modifications in the standard method given in their earlier report. The technique recommended in this later report was the one tested in the present work. Weinzirl and Thomas [14] as members of this sub-committee made a series of comparative tests using both the new standard method and Rettger's method, securing results slightly favoring the standard method.

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[6] Hansen, E. C. Recherches sur les organismes qui, à différentes époques de l'année, se trouvent dans l'air, à Carlsberg et aux alentours, et qui peuvent se développer dans le moût de bière. *Compt. rend. d. travaux du Labor. de Carlsberg.* 1:49–75, 1879, 1:197–218, 1882. (French trans. from orig. Danish.)

[7] Miquel, P. Les organismes vivants de l'atmosphère. Paris, 1883.

Idem. De l'analyse microscopique de l'air au moyen de filtres solubles. *Ann. Microg.* 1:153–167, 1888–89.

Idem. Dixième mémoire sur les pousières organisés de l'air et des eaux. *Ann. Observ. Munic. Montsouris* (Paris), 1888. p. 413–600.

[8] See footnote 3.

[9] Sopor, G. A. The air of the New York subway prior to 1906. *Techn. Quarterly,* 20:58–118, 1907.

[10] See footnote 4.

[11] Weinzirl, J., and Fos, M. V. Bacteriological methods for air analysis. *Amer. Jour. Pub. Hyg.,* 20 (N. S. 6): 633–638, 1910.

[12] Committee on Standard Methods for the Examination of Air, Report. *Amer. Jour. Pub. Hyg.,* 20 (N. S. 6):346–360, 1910.

PRESENT STUDIES OF METHODS.

A. TECHNIQUE.

The material to be analyzed was plated in duplicate — or in triplicate in some cases — within one hour after sampling. The medium used was an agar made according to the formula now recommended by the Committee on Standard Methods for Bacterial Milk Analysis [15] except that the acidity was usually between 1.2 and 1.5 per ct. normal acid to phenolphthalein. The plates were incubated in a constant temperature incubator for five days at 18° C. (later 21° C.) and then for two days at 37° C. Except in a few instances, check plates were made which were designed to test the sterility of the filter tubes, water blanks, and petri plates. In the few cases where the check plates contained more than the occasional colonies which appear as a result of accidental contaminations, the entire results of the tests were discarded.

The counting of the colonies on the plates was done with the aid of a hand lens. The term "bacteria" used throughout this paper includes yeasts and actinomycetes, since no attempt was made to separate these from the bacteria proper. Mold growths were noted and recorded separately, but are not given here. In general they were abundant and at times more numerous than the bacterial colonies.

In some places, for convenience of expression, the terms "germ content" and "number of bacteria" have been used in this paper as though they referred to the actual number of individual bacteria present. As is well known the plate method of counting bacteria does not give the number of individual bacteria but rather the number of colonies which develop in solid nutrient media per unit volume or area.

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[13] Committee on Standard Methods for the Examination of Air. Progress Report. *Amer. Jour. Pub. Health*, 3:78–86, 1913.

[14] Weinzirl, J., and Thomas, J. B. A comparison between the sand filtration method and the bubbling method for enumerating bacteria in air. *Amer. Jour. Pub. Health*, 3:171–174, 1913.

[15] Committee on Standard Methods for Bacterial Milk Analyses, Report. *Amer. Jour. Pub. Health*, 5:64, 1915.

DESCRIPTION OF AEROSCOPES

The term " aeroscope," as used in this paper, indicates an apparatus used to gather bacteria from the air. It does not include the accessories, such as the aspirator bottle and its connections. In the past there has been some variation in the use of the term among different writers. Usually where the principle of filtration through sand was employed, the apparatus has not been called an " aeroscope," while the term is almost always applied to an apparatus in which a liquid is used as the filtering agent. There seems no good reason for this distinction. Likewise there seems to be very little justification for restricting the word to a part of the apparatus, as is done by some.

The aeroscope referred to in this paper (Fig. 1) as the " standard " was constructed as follows: A 10-millimeter layer of sand which has been passed through a 100-mesh sieve and has been retained by a 160-mesh[16] sieve is supported within a cylindrical glass tube 70 millimeters in length and 15 millimeters in diameter upon a layer of bolting cloth folded over the end of a rubber stopper. Through a perforation in the stopper there passes a tube 6 millimeters in diameter and 40 millimeters in length. This tube is attached to the aspirator bottle. The upper end of the cylindrical tube is closed by a perforated rubber stopper through which is passed a glass tube 40 millimeters in length and 6 millimeters in diameter bent at an angle of 45° in order to prevent precipitation of bacteria or dust particles into the aeroscope.

In using this aeroscope a measured volume of air is filtered through the tube, the sand shaken out into 10 cubic centimeters of sterile water, and aliquot portions of this suspension plated on nutrient agar.

The " modified " form (Fig. 2) of the standard aeroscope (Fig. 1) differs from the standard in that the lower rubber-stopper and bolting-cloth supports are eliminated and the small tube is fused into the larger one. The layer of sand is supported by a layer of cotton resting on the shoulder at the junction of the large and small tubes. The upper stopper is replaced by a cork stopper, a construction that permits the aeroscope to be sterilized by dry heat instead of by steam. After this tube was devised it was discovered that Koning[17] had used one of similar construction, although he used a coarser sand in the filter.

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[16] The specifications in the standard method call for a 200-mesh sieve.

Rettger's aeroscope (Fig 3) may be described in his own words:[18]

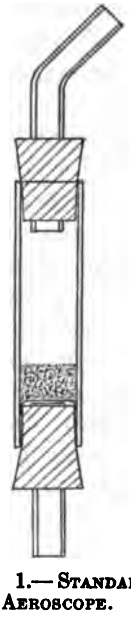

FIG. 1.—STANDARD AEROSCOPE.

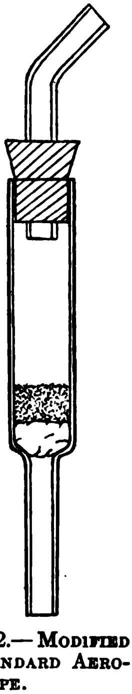

FIG. 2.—MODIFIED STANDARD AEROSCOPE.

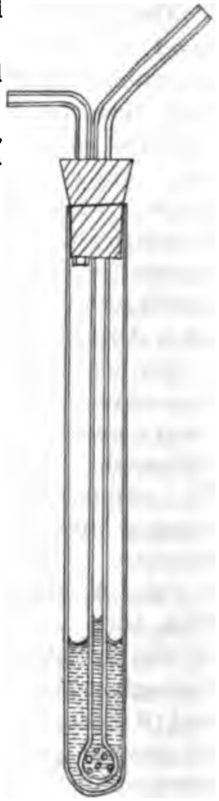

FIG. 3.—RETTGER AEROSCOPE.

> The entire special apparatus consists of a glass tube with a small round bulb at one end. The bulb has eight or ten small perforations, which serve the purpose of allowing the air to pass through at a rapid rate and yet divide the gas to such an extent that every particle of it is brought into close contact with the filtering fluid. This glass tube or aeroscope is fitted into a small, thick-walled test tube by means of a rubber stopper, which also bears,

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[17] Koning, C. J. Biologische und biochemische Studien über Milch. IV. Teil. Die Stall-Luft. *Milchw. Zentbl.*, 2:241–263, 313–338, 1906. Translated by Johs. Kaufmann from *Pharm. Weekbl.*, 1905. (Orig. not seen.)

[18] Pages 462–463. See footnote 4.

besides the aeroscope, a short glass tube bent at right angles. The upper end of the aeroscope is bent at an angle of about 45°, in order to prevent bacteria and particles of dust from falling into the open end of the tube, and still permit of the tube being drawn through the stopper without difficulty.

Five cubic centimeters of physiological salt solution are used as the filtering agent. This is plated in aliquot portions, after drawing a measured quantity of air through the aeroscope.

B. EXPERIMENTAL DATA.

COMPARISON OF VARIOUS TYPES OF AEROSCOPES

The problem of demonstrating which of two aeroscopes is the more accurate is attended with certain practical difficulties. It is not practicable to set up two aeroscopes side by side and determine which is the more reliable, since the bacterial quality of the air is not uniform enough to make it possible to secure strictly comparable results. For this reason some authors have frankly given up this procedure and have resorted to determinations of the filtering efficiency of each filter independently of the other. In these efficiency tests the aeroscopes are set up in tandem — that is, end to end — so that the air passes through one filter and then through the other. The percentage efficiency of the aeroscope is determined by calculating what percentage of the total number of bacteria appear in the first aeroscope. Percentages obtained by two different aeroscopes in this way ought not to be compared unless they have been calculated from numbers of approximately equal size. The fairest way of making these comparisons is to carry on the two kinds of tests simultaneously. This was not realized in this work until contradictory results had been obtained by the use of the tests separately.

The first three series of analyses made in this investigation illustrate this point. These will only be given in summarized form as the details can be found in the previous publication already mentioned.[19] In the first series in which the standard aeroscope was used the averages of twenty-eight percentage efficiency tests resulted in 59 colonies per liter of air in the first aeroscope (75.9 per ct.) and 18.7 colonies per liter of air in the second aeroscope (24.1 per ct.). Disregarding three tests where leakage about the connections between the two aeroscopes evidently occurred, the twenty-five remaining tests gave averages of 50 colonies per liter of air for the first aeroscope (91.4 per ct.) and 4.9 colonies per liter of air for the second aeroscope (8.6 per ct.). A similar series of thirty-three tests with the Rettger aeroscope resulted in an average plate count of 18.8 for the first aeroscope and 2.6 for the second (88 per ct. efficiency). Leaving out three evident cases of leakage, the averages for the remaining thirty tests were 19.8 colonies per plate for the first aeroscope and 1.5 colonies per plate for the second (93 per ct. efficiency). The last of the three series mentioned above consisted of thirty direct comparisons between the counts obtained with both types of aeroscope. The averages were 21.5 colonies per liter for the Rettger aeroscope and 48.6 colonies per liter for the sand aeroscope. Thus while the percentage efficiency tests favored the Rettger aeroscope, the direct comparisons favored the sand aeroscope.

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[19] See footnote 5.

One of the difficulties constantly encountered in air-filtration work is leakage. When this takes place at some point between the filter and the aspirator, the result is that some of the air does not pass through the filter, and therefore the results are low. When the leakage takes place between the two aeroscopes set up in tandem, the result is that some of the air goes through the second filter only, making the percentage efficiency of the filter appear lower than it really is. Neither of these possibilities was fully appreciated at first and therefore not sufficiently guarded against.

Another possible condition may have had a marked influence on these results. At times, when sand-filters are sterilized in the autoclave, the sand sticks together to such an extent that cracks appear in it. Such cracked filters are obviously not capable of catching all of the bacteria because of the open pores or lanes through which they may pass. In all of the tests given in this bulletin, such obviously leaky filters were never used, so that the results given all favor the standard areoscope to that extent.

To overcome the effect of caking by the sand in the sand aeroscope the latter was modified at this point to permit of dry sterilization. A cotton layer sufficiently firm to support the column of sand was inserted just above the lower rubber stopper. This stopper was then removed until the aeroscope proper had been sterilized with dry heat. After sterilization the rubber stopper was carefully re-inserted. This modification of the standard aeroscope was tested and two series of 43 and 38 trials gave contradictory and inconclusive results. It was then further modified so as to eliminate the rubber stopper altogether. The final form of aeroscope tested has already been described and figured on pages 157 and 158.

COMPARISON OF THE EFFICIENCY OF THE MODIFIED STANDARD AND THE STANDARD AEROSCOPES

In comparing the efficiency of the aeroscopes of the standard type with those of the modified type, the aeroscopes were set up in tandem and the tandem couples of each type of filter were used for duplicate analyses. The openings of the aeroscopes were always placed side by side, and similar aspirators were used so that the rate of filtration could be kept the same. The samples of air were all taken in the stable when the cows were in their stalls and during such operations as feeding or milking. This was done because previous experience had shown that the germ content of the air of the stable when it was empty or when everything was quiet was so low that very few colonies appeared on the plates. In every case the sand was shaken out into 10 cubic centimeters of sterile physiological salt solution. One cubic centimeter of the resulting bacterial suspension was added to each plate. Plating was done in duplicate in the first series given in Table I and in triplicate in the second series.

In the first series of tests reported in Table I the joints between the two aeroscopes were not sealed to prevent leakage, but were carefully examined to discover possible leakage. As the results show (see tests Nos. 2, 9, and 10), some leakage did occur, probably through the cork stoppers which were used to connect the tubes. For this reason, in the second series of tests all joints which could possibly leak were sealed with paraffin after the apparatus had been sterilized.

The first series of tests (Table I) gave an average of 217 colonies per plate for the first aeroscopes of the tandem pairs in the modified form of aeroscope, with 12 per plate (5.7 per ct.) for the second aeroscopes. In comparison with this, the first tubes of the selected (p. 160) standard aeroscopes gave an average of 175 colonies per plate, with 29 colonies per plate (13.2 per ct.) for the second aeroscopes of the tandem pairs.

Twenty-five comparative tests in the second series (Table I) under the rigid conditions just described gave an average of 400 colonies per plate for the first aeroscope of the modified form and 3

TABLE I.—COMPARATIVE COUNTS OBTAINED WITH MODIFIED STANDARD AND STANDARD AEROSCOPES SET UP IN TANDEM.

Test No.	Modified Standard Aeroscope.			Standard Aeroscope.		
	Plate count:		Count per liter.	Plate count:		Count per liter.
	First tube.	Second tube.		First tube.	Second tube.	
1	536	1	335	....	6	....
2	175	68	109	....	31	....
3	234	0	146	131	13	82
4	32	1	20	10	0	6
5	54	0	34	118	1	74
6	289	1	181	249	4	156
7	165	4	103	3	6	2
8	81	4	51	26	7	16
9	258	42	161	138	189	86
10	288	46	180	277	33	173
11	174	4	109	122	19	76
12	581	7	363	506	12	316
13	443	5	277	459	99	287
14	64	2	40	53	12	33
15	51	7	32	165	22	103
16	140	6	88	191	15	119
Average	217	12	139	175	29	109
1	185	0.5	116	116	15	73
2	511	1.5	319	582	17	264
3	382	11.0	239	378	80	236
4	500	2.0	313	485	18	303
5	382	0.5	239	394	25	246
6	128	6.0	80	164	22	103
7	179	6.5	112	137	17	86
8	185	0.0	116	120	12	75
9	185	2.0	116	222	75	139
10	391	4.5	244	437	24	273
11	436	3.0	273	328	39	205
12	364	1.0	228	273	32	171
13	854	4.7	534	1,031	90	644
14	813	1.3	508	803	77	502
15	1,050	9.0	656	943	131	589
16	1,281	1.3	801	857	152	536
17	248	1.0	155	237	7	148
18	225	1.7	141	273	7	171
19	338	4.3	211	359	52	224
20	273	3.0	171	287	139	179
21	204	1.7	128	248	8	155
22	136	2.0	85	195	7	122
23	322	3.0	201	391	1	244
24	224	1.3	140	143	9	89
25	217	1.0	136	218	3	136
Average	400	3.0	250	384	42	237

per plate (0.75 per ct.) for the second. The selected standard aeroscopes gave an average of 384 colonies per plate for the first aeroscopes and 42 per plate (about 10 per ct.) for the second ones. Thus, while the standard aeroscopes allowed an appreciable number of bacteria to pass through into the second tube, the modified form probably did not allow any bacteria to pass through into the second tube, the small numbers of colonies occurring on the plates being scarcely more than the numbers that appeared on the check plates.

The second series (Table I) shows conclusively that the standard aeroscopes allow bacteria to pass through the sand layer, since all other leakage was cut off by the paraffin seal. It is probable that a more careful selection of those standard aeroscopes in which the layer of sand was least affected by the steam sterilization would have resulted in a higher average efficiency than was found in these tests. On the other hand, if no selection had been made, the results would undoubtedly have shown a much lower average efficiency. The mere fact that such a selection is necessary in order to secure reliable results is of itself a serious weakness in the standard procedure.

The idea that the low numbers on the plates of the second aeroscope in the train of the modified standard aeroscopes really represent contaminations is further supported by the fact that an examination was made of the cotton plugs used to support the sand filter in the modified aeroscope. In 25 of the tests, after the sand in the first tube had been poured out, the upper end of the tube that had been in contact with this sand was carefully flamed and the cotton plug blown out into a test tube containing 10 cubic centimeters of sterile water. After a thorough shaking, this bacterial suspension was plated in duplicate in 1 cubic centimeter quantities. In the entire series the average number of colonies that developed per cotton plug was only 50 (5.0 colonies per plate), the highest number being 132 (13.2 colonies per plate) and the lowest 0. Undoubtedly a large part, if not all, of the bacteria present were really in the sand or clinging to the walls of the aeroscope and were scraped out of the tube with the cotton plug. Even if they were all present in the cotton, they represent less than 1 per ct. of the total number of bacteria caught.

Since it was desirable to know whether the sand filter was equally efficient when a more rapid current of air was passed through it, a new series of analyses was undertaken. In this series of 22 tests, the air was aspirated at the rate of 1 liter per minute or even faster in some cases (7 liters in five minutes), while all of the previous analyses had been made with an aspiration rate of 1 liter in two minutes. Connections were sealed with paraffin, as before. The material was plated on both agar and lactose agar, but only the results of the former will be discussed here. The samples were plated in triplicate, as in the preceding series. The results of this series of tests are given in Table II.

TABLE II.— EFFICIENCY TESTS OF THE MODIFIED STANDARD AEROSCOPE.

[Aeroscopes set up in tandem. Aspiration more rapid than in previous tests.]

Test No.	Plate count:		Count per liter.	Test No.	Plate count:		Count per liter.
	first tube.	second tube.			first tube.	second tube.	
1	58	6	83	14	56	7	80
2	48	4	69	15	93	11	133
3	29	1	41	16	75	7	107
4	45	13	64	17	60	2	86
5	28	3	40	18	43	2	61
6	138	1	197	19	15	0	21
7	205	2	293	20	66	0	94
8	282	1	403	21	43	1	61
9	94	1	134	22	30	1	43
10	74	2	106	23	43	1	61
11	38	2	54				
12	66	0	94	Average	76	3	105
13	55	0	79				

From this table it will be seen that the first tube of the modified form of aeroscope gave an average of 76 colonies per plate (96.3 per ct.), while the second tube gave 3 colonies per plate (3.7 per ct.). The cotton plugs were plated as before, resulting in the development of 36 colonies per plug (3.6 colonies per plate). Since the number of colonies that appeared on the plates made from the second tube was the same as in the previous series (Table I, second series), it was felt that the lower percentage of efficiency in this case was largely the result of the fact that fewer bacteria were present per liter of air.

COMPARISON OF THE EFFICIENCY OF THE MODIFIED STANDARD AND THE RETTGER AEROSCOPES.

Since the previous work with the Rettger aeroscope had not given conclusive results, another series of tests was carried out. As before, two large aspirator bottles were used and 8 liters of air were drawn through each filter at the rate of ½ liter per minute. The aeroscopes were set up in tandem and all joints carefully sealed with paraffin. In this case the suspensions were plated upon two different media, but only those results secured by the use of plain nutrient agar will be discussed at this place, the other results being referred to later. (See p. 174.) Since the results given as plate counts from the two aeroscopes are not comparable because the Rettger suspensions consisted of 5 cubic centimeters and the sand suspensions of 10 cubic centimeters of physiological salt solution, they have also been computed per liter of air. The latter figures are given in the fourth and seventh columns of Table III. In this series of comparisons the Rettger suspensions were plated in duplicate and the sand suspensions in triplicate.

A break has been made in Table III because of a slight change which was made in the method of plating the bacterial suspensions from the Rettger tubes. In the first 15 analyses the aeroscope arm through which the air enters was washed out once, just before the bacterial suspension was used for plating, by drawing the suspension up into this arm by suction and then releasing it. This was done because it was realized that there was danger that some bacteria would be lost by clinging to the moist inner surface of this tube. As the counts were made, it became evident that the number of colonies appearing per liter from the Rettger aeroscope was less than the number appearing per liter from the modified sand aeroscope. For this reason, beginning with test No. 16 the rinsing of the entrance arm to the Rettger aeroscope was done more thoroughly (several times). By this means the number of colonies appearing on the Rettger plates was increased, showing that the surmised effect of this moist tube was probably true. This effect of the long entrance tube in reducing the number of bacteria in the water filter is also realized by Rettger, for he states [20] that one may expect as high as a 15 per ct. error in this way. For this reason he recommends drawing the tube out of the aeroscope (after the steam sterilization and before use) and flaming it in order to make sure that the tube will be dry when used. This was not done in the present series of tests, because it was felt that this manipulation after sterilization introduced too great a chance of accidental contaminations.

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[20] Page 467. See footnote 4.

TABLE III.—COMPARATIVE COUNTS OBTAINED WITH MODIFIED STANDARD AND RETTGER AEROSCOPES.

TEST No.	MODIFIED STANDARD AEROSCOPE.			RETTGER AEROSCOPE.		
	Plate count of first tube.	Plate count of second tube.	Count per liter.	Plate count of first tube.	Plate count of second tube.	Count per liter.
1	171	9.3	214	35	5.0	22
2	88	2.3	110	47	1.5	29
3	122	4.0	153	61	2.5	38
4	125	2.6	156	59	10.5	37
5	73	1.3	91	69	9.0	43
6	117	2.0	146	62	19.0	39
7	91	0.0	114	27	10.5	17
8	73	2.3	91	43	1.0	27
9	46	1.6	58	32	7.0	20
10	48	1.3	60	22	0.0	14
11	45	1.0	56	10	1.0	6
12	79	1.0	99	27	3.0	17
13	115	1.6	144	27	1.0	17
14	132	1.6	165	63	1.5	39
15	130	2.6	163	15	15.0	9
Average	97	2.3	121	40	5.8	25
16	51	2.3	64	69	5.5	43
17	47	0.6	59	131	0.5	82
18	73	0.0	91	....	....	......
19	79	1.0	99	87	0.0	54
20	68	1.6	85	74	2.0	46
21	178	2.3	223	31	0.5	19
22	81	1.6	101	44	0.5	28
23	72	0.6	90	15	2.0	9
24	47	1.0	59	13	3.0	8
Average	77	1.0	97	58	1.8	36

The results secured before and after the change of procedure noted were as follows: When the entrance tube was rinsed but once, the Rettger aeroscope gave an average of 25 and the modified standard aeroscope gave 121 colonies per liter. After the rinsing was done more thoroughly, there was still a large discrepancy in results, the Rettger filter giving an average of 36 and the modified sand filter an average of 97 per liter.

In the first 15 tests the average counts obtained from the second tube of each tandem pair was 2.3 colonies per plate for the modified standard aeroscope and 5.8 per plate in the case of the Rettger aeroscope. On the basis of these numbers, the percentage efficiencies calculated for the two aeroscopes are 97.7 and 87.3, respectively. The low percentage efficiency obtained with the Rettger aeroscope is somewhat misleading, owing to the fact that in this case the total numbers obtained by both aeroscopes of the tandem pair are low. In the last nine tests the percentage efficiencies were 98.8 for the modified standard aeroscope and 97.1 for the Rettger aeroscope.

COMPARISON OF RETTGER AEROSCOPE WITH THREE TYPES OF THE MODIFIED STANDARD AEROSCOPE.

In order to ascertain, if possible, the reason why the Rettger aeroscopes had given such decidedly lower results in the previous series of analyses than the sand filters, another series of analyses was made. From the data already secured it did not seem probable that the lower figures could be explained entirely by loss due to the clinging of bacteria to the entrance tube. For that reason a series of tests was planned in order to discover whether the difference in the size of the entrance tubes had any effect on the number of bacteria caught in the filters. Four types of aeroscopes were used: (1) The Rettger aeroscope; (2) the modified standard aeroscope used in the preceding experiments; (3) an aeroscope of the same type as No. 2 except that the entrance tube was of the same diameter and length as the one used in the Rettger aeroscope; and (4) an aeroscope of the same type as No. 2 except that the top was left wide open when the air was being drawn through it, precipitation of bacteria and dust being prevented by means of a shield placed above it.

Ten liters of air were drawn through each aeroscope at the rate of ½ liter per minute. Five cubic centimeters of sterile water was used in the Rettger aeroscope as the filtering agent and the same quantity of sterile water was used in making the bacterial suspensions of the sand in the other aeroscopes. Plating was done in triplicate in the usual manner, the entrance tubes to the Rettger aeroscopes being more thoroughly rinsed (about 12 times) than had previously been done. The results of 21 such comparative tests computed on the basis of per liter counts are given in Table IV. The averages of the tests showed that the plates made from the Rettger aeroscopes (column 1) developed 90 colonies per liter, those from the modified standard aeroscopes (column 2) developed 90 per liter, those from the modified aeroscopes with the small opening (column 3) developed 97, while those from the modified aeroscope protected by a shield (column 4) developed 80 per liter. Individual results varied greatly,

TABLE IV.— COMPARATIVE COUNTS OBTAINED WITH FOUR DIFFERENT TYPES OF AEROSCOPES.

[All counts given per liter of air.]

TEST No.	Rettger aeroscope.	Modified standard aeroscope.	Modified standard aeroscope.*	Modified standard aeroscope.†
1	23	20	19	....
2	67	34	33	....
3	26	99	23	....
4	14	40	12	....
5	14	19	11	....
6	98	265	143	....
7	73	73	305	110
8	52	248	48	129
9	38	75	83	155
10	60	120	107	75
11	171	115	39	34
12	30	31	15	25
13	39	40	91	33
14	73	58	101	56
15	27	121	81	111
16	211	95	192	94
17	116	77	83	87
18	77	79	63	72
19	80	229	291	189
20	133	44	124	126
21	31	24	24	26
22	36	28	48	46
23	65	27	42	32
24	38	14	12	33
25	156	178	188	95
26	41	123	53	50
27	343	94	57	98
Average for 21 tests	90	90	97	80
Average for 27 tests	79	88	85	....

* The ordinary inlet tube of this form of aeroscope (see Fig. 2) was replaced by an inlet tube of the diameter and length of the inlet tube of the Rettger aeroscope.

† No cork or inlet tube was placed in the upper end of these aeroscopes. Precipitation of dust was prevented by means of a shield placed above the opening.

sometimes one aeroscope and sometimes another giving the highest numbers. From this series of analyses it seems evident that the size of the opening has little influence upon the number of bacteria caught by the filters, and it also shows that under some conditions the Rettger aeroscope may catch as many bacteria as the sand filters. Just why the Rettger aeroscope should have proved more efficient in the series of tests given in Table IV than in the series given in Table III is not evident from the analyses given, unless it was due to the more thorough rinsing of the inlet tube.

EFFECT OF USE OF LIQUID FILTERS ON COUNT.

Since one of the chief differences between the Rettger type of aeroscope and the modified standard aeroscope is in the filter and since there are several possible ways in which the use of a liquid filter might tend to lower the count, further investigations were made. As both distilled water and physiological salt solution had been used in making the tests with the Rettger aeroscopes, series of analyses were made with both of these in which the bacterial suspensions were plated at once and again three hours later. The actual time during which these substances might exert a deleterious influence upon the bacteria was about thirty minutes longer in the case of the Rettger aeroscope than the times given, as it was impossible to make the first plating until about that interval of time had elapsed after first starting the air bubbling through the liquid.

While these tests were being made with the Rettger aeroscope, duplicate tests were run with the modified standard aeroscopes. The bacterial suspensions were plated in this case immediately after being made and again after an interval of three hours. The detailed results will not be given, since they were somewhat contradictory and bear upon another line of investigation now in progress. In some cases there was a great reduction in numbers of colonies appearing on the plates after the bacterial suspensions had stood for the three hours, in others little or no reduction, and in some cases even an increase. There seemed to be little difference between the action of the distilled water and that of the physiological salt solution.

One interesting fact that appeared as the result of these comparative tests was that the Rettger filters in this series of analyses caught nearly as many bacteria as the sand filters. The exact averages for the 26 tests were 142 colonies per liter for the Rettger aeroscope as compared with 173 for the modified standard aeroscope. Of all analyses given in this paper, 82 give a direct comparison between the Rettger aeroscope and the modified standard aeroscope. Of these 82 comparisons; 49 show larger numbers of bacteria caught by the sand filters, 17 show excesses for the water filter, and 16 give practically the same figures for both. However, if we take only the last 54 of these analyses, omitting the first comparisons, which were not properly carried out in all their details, the showing is more favorable for the Rettger aeroscopes. In these there were 22 excesses for the sand filter, 16 for the liquid filter, and 16 where the results were practically identical.

From these analyses it must be concluded that the Rettger aeroscope is probably very nearly as efficient as the modified standard aeroscope in the hands of an experienced man. There are several things about it, however, that are liable to cause trouble and others that make it less convenient to use. One already mentioned is the possible injurious effect of the liquid used as a filter upon the bacteria before the material can be plated, owing to absorbed gases, unfavorable osmotic action, or other causes making it necessary to complete the plating as quickly as possible after starting the analysis. This one objection makes it inadvisable to use this type of aeroscope for analyses made at a distance from the laboratory. A second difficulty is the need of great care to prevent bacteria from being held on the moist inner surface of the inlet tube. A third is the necessity of steam sterilization, which occasionally loosens the joints about the cork, causing inaccuracies. Since the modified form of aeroscope met all of these difficulties and was cheaper, easier to operate, less likely to break, and more adaptable to field work, it was decided to use this in the investigation to which the work recorded in this paper was preliminary.

COMPARISON OF RESULTS OBTAINED BY DUPLICATE ANALYSES MADE WITH THE SAME TYPE OF FILTER.

Inasmuch as the conclusions drawn from data already reported are mainly based upon the averages of from 25 to 30 comparisons, it may be instructive to find out whether such conclusions are justified or whether they are due to incidental differences in the bacterial quality of the air. Accordingly three series of comparative tests were made, using the same type of filter on each side of the comparison. The first series of 32 such comparisons is recorded in Table V. In this case two sand filters of the type described on page 160 were used. Six liters of air artificially enriched with dust were drawn through each filter at the same rate. The sand was washed in 5 cubic centimeters of sterile water, and 1 cubic centimeter of the suspension was added to each plate.

TABLE V.— COMPARATIVE COUNTS OBTAINED WITH TWO STANDARD AEROSCOPES MODIFIED TO ALLOW DRY STERILIZATION.

TEST No.	PLATE COUNT.		COUNT PER LITER OF AIR.	
	Sample.	Duplicate.	Sample.	Duplicate.
1	109	132	91	110
2	358	314	298	262
3	126	357	105	298
4	508	268	423	223
5	323	243	269	203
6	140	89	117	74
7	222	352	185	293
8	194	161	162	134
9	65	73	54	61
10	90	88	75	73
11	126	81	105	68
12	210	186	175	155
13	178	167	148	139
14	318	184	265	153
15	132	157	110	131
16	96	57	80	48
17	710	933	592	778
18	635	602	529	502
19	600	721	500	601
20	862	786	718	655
21	504	212	420	177
22	222	401	185	334
23	384	381	320	318
24	730	886	608	738
25	487	405	406	338
26	370	430	308	358
27	154	194	128	162
28	148	213	123	178
29	20	45	17	38
30	59	25	41	21
31	23	23	19	19
32	93	137	78	114
Average	287	290	239	242

As will be seen from Table V, 32 tests gave an average of 287 colonies per plate in one sample of air and 290 in the duplicate, or 239 colonies per liter in one sample and 242 in the duplicate. Such close agreement of results, even in series as long as this, are rarely obtained with the technique used. Marked variations occurred in individual cases, however, showing the need of a long series of tests from which to draw conclusions.

DUPLICATE SAMPLING WITH A REVERSIBLE ASPIRATOR.

These tests differed from those just given in that the ordinary aspirator bottles were replaced by a reversible aspirator. A Y connection was placed in the system so that the current of air could be drawn first through one aeroscope and then through the other. Two liters of air were usually drawn through each aeroscope before diverting the current. In this way either 18, 24, or 30 liters of stable air were drawn through each aeroscope, the larger volume being used at the beginning of the series of analyses and the smaller toward the end, when it was discovered that the plates were overcrowded with colonies. The average numbers of colonies per plate for the two series of 30 tests[21] were 673 and 643. In this comparison the individual results agree a little better than in the previous series, but this is probably partly due to accident and partly to the influence of overcrowded plates. If nine of the comparisons with the most overcrowded plates are left out of the calculation, the averages become 276 for the one set of analyses and 226 for the other. Some individual analyses present wide variations, but the averages show that fairly comparable duplicate results can be secured with this type of aeroscope when used in a series of analyses.

DUPLICATE SAMPLING WITH RETTGER AEROSCOPES SET UP IN TANDEM.

A series of 20 duplicate analyses were made with Rettger aeroscopes, using 18-liter bottles as aspirators and filtering 15 liters of stable air through each aeroscope. Five cubic centimeters of sterile water (used instead of physiological salt solution in order to avoid foaming) was used as the filtering agent and 1 cubic centimeter of the suspension was added to each petri plate. The aeroscopes were also set up in tandem connected by a continuous glass tube. Table VI gives the results of these analyses in detail.

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[21] See p. 361 in reference given in footnote 5 for detailed record of these analyses.

Table VI.—Duplicate Counts Made With Rettger Aeroscopes in Tandem Couples.

Test No.	Sample.			Duplicate.		
	Plate count of first tube.	Plate count of second tube.	Count per liter.	Plate count of first tube.	Plate count of second tube.	Count per liter.
1	10	0.6	3	24	0.3	8
2	0	0.3	0	1	0.6	0
3	5	11.0	2	6	6.0	2
4	15	0.6	5	12	0.3	4
5	31	0.0	10	42	0.3	14
6	5	0.6	2	3	0.3	1
7	3	0.6	1	4	0.3	1
8	12	0.6	4	5	0.0	2
9	29	9.6	10	17	1.3	6
10	8	3.6	3	8	2.3	3
11	12	0.6	4	5	1.0	2
12	71	3.0	24	47	3.0	16
13	41	3.3	14	20	1.0	7
14	171	52.5	57	57	23.6	19
15	35	8.6	12	13	3.6	4
16	52	9.3	17	116	3.0	39
17	166	3.0	55	52	3.0	17
18	51	6.0	17	50	1.0	17
19	132	5.0	44	124	3.3	41
20	108	2.6	36	129	2.3	43
Average	48	6.0	16	39	2.8	12

Many of the results show very few colonies per plate, especially where the analyses were made when the cows were out of the stable and everything was quiet. In this respect these figures are unsatisfactory, since low figures greatly magnify contamination errors. The averages of 20 tests gave 48 colonies per plate for the first sample and 39 for the duplicates. The second tubes of each tandem couple gave average counts of 6 (88.8 per ct. efficiency) and 2.8 (93.3 per ct. efficiency) colonies per plate, respectively.

These three series of comparative tests show clearly that caution must be exercised in accepting the figures of any single comparison as correct. On the other hand, the average of a series of comparative analyses apparently gives reliable results.

COMPARISON OF VARIOUS MEDIA FOR BACTERIAL ANALYSIS OF AIR.

In the course of this work several comparative series of tests were made to determine whether or not a more suitable medium than ordinary agar might be found. The media so compared with nutrient agar were as follows: (1) Nutrient gelatin, containing the same ingredients as the agar except for the substitution of 10 per ct. of gelatin for 1.5 per ct. of agar; (2) a gelatin medium with 20 per ct. of gelatin; (3) a gelatin medium made with soil extract;[22] (4) lactose agar, containing 1 per ct. of lactose in addition to the usual ingredients; and (5) asparaginate agar,[22] an agar to which only compounds of known chemical composition have been added.

The problem was not studied exhaustively enough to prove that the agar medium used in this work was the best possible medium for air work, but the data gathered did warrant the conclusion that it was better than any medium compared with it. The last two media mentioned above gave only slightly lower results than the ordinary agar, but the three gelatin media gave decidely lower results, probably due in part to the lower incubation temperature necessary when using them and in part to liquefaction. The 20 per ct. gelatin gave the highest results of the gelatin media, owing to diminished liquefaction of the medium.

COMPARISON BETWEEN TWO METHODS OF MEASURING BACTERIAL PRECIPITATION.

In the study of the main problem already mentioned, to which this study of technique was preliminary, it was necessary to determine the number of bacteria precipitated upon a given area in a given time. No standard procedure is given for this by the Committee on Standard Methods for the Examination of Air, although it seems evident that there should be such a recognized procedure. This determination is usually made by exposing a petri plate containing solidified agar or gelatin for a given period of time and counting the colonies that developed on the plates after incubation.

It was felt, however, that this method was entirely inadequate, as it does not give a true measure of the number of bacteria falling on the plate. This comes about because of the possiblity that a dust particle may carry more than one bacterium. Ordinarily, but one colony develops from a dust particle, so that the number of colonies measures the number of bacteria-laden dust particles falling on the plate rather than the number of bacteria falling on the plate.

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[22] Conn, H. Joel. Culture media for use in the plate method of counting soil bacteria. N. Y. Agr. Exp. Sta., Tech. Bul. 38, 1914.

The method for determining this bacterial precipitation which was tried was to place 500 cubic centimeters of sterile water in a sterilized pail covered with a metal lid. Check samples were taken and the lid removed for a given length of time. Samples of the water were then taken after thorough agitation and plated as soon as possible. Later it was discovered that Koning[23] had used milk as the medium for catching the precipitated bacteria. Other liquids might be used in the same way.

The satisfactory nature of this technique was demonstrated by the results secured in 34 comparative tests between this technique and the plate-exposure technique. The results are given in detail in Table VII.

In tests 1–12 and 23–34 the petri plates were exposed for five minutes but this length of time was abandoned because of the overcrowding of the plates. In the other cases, the numbers given were secured by adding the results secured by exposing four different plates consecutively for one and one-fourth minutes each. In this way the same time of exposure was secured without overcrowding of plates.

The average result secured in these tests was 8 colonies per square centimeter, secured from a 5-minute exposure where this was determined by exposed petri plates. Where the pail method of exposure was used, the similar figures were 78 colonies per square centimeter. In the most favorable cases the plate-exposure method gave only one-half of the numbers secured in the other way, while in the least favorable cases the plate-exposure method gave only 1 colony to 32 colonies which appeared on the plates made from the pails. Frequently, the colonies that appeared on the plates which had been exposed showed by their very nature that they were of composite origin.

It seems strange that this fundamental weakness of the plate-exposure method has not been properly appreciated by investigators, for it was recognized by Hueppe[24] as long ago as 1891.

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[23] Page 251 et seq. See footnote 17.

[24] Page 480. Hueppe, Ferdinand. Die Methoden der Bakterien-Forschung. 5th Edit. Wiesbaden, 1891.

TABLE VII.—COMPARISON BETWEEN THE EXPOSED-PLATE AND THE EXPOSED-PAIL METHODS OF MEASURING BACTERIAL PRECIPITATION.

Test No.	Precipitation on 1 Sq. Cm. in 5 Min.		Ratio.	Test No.	Precipitation on 1 Sq. Cm. in 5 Min.		Ratio.
	Exposed-plate method.	Exposed-pail method.			Exposed-plate method.	Exposed-pail method.	
1	6.0	56	1:9	23	15.7	216	1:13
2	6.4	58	1:9	24	5.9	81	1:13
3	7.8	261	1:32	25	4.9	36	1:7
4	6.1	51	1:9	26	7.4	17	1:2
5	3.2	28	1:9	27	4.3	13	1:3
6	6.0	34	1:6	28	3.4	23	1:7
*7	8.7	124	1:14	29	11.1	100	1:9
*8	7.8	105	1:13	*30	13.1	216	1:16
9	8.4	63	1:8	31	13.2	30	1:2
10	7.2	45	1:6	32	5.5	32	1:6
11	5.4	62	1:11	33	7.1	28	1:4
12	11.6	109	1:9	34	5.9	53	1:9
13	19.9	250	1:12	35	9.2	53	1:6
14	9.3	36	1:4	36	11.0	68	1:6
15	7.0	75	1:11	37	7.7	96	1:13
16	7.7	49	1:7	38	8.3	58	1:7
17	6.3	81	1:13	*39	11.1	120	1:10
18	5.5	81	1:15	*40	11.6	118	1:10
19	11.0	94	1:9				
20	9.4	184	1:20				
21	10.4	149	1:14	Average.	8.1	78.5	1:10
*22	9.2	199	1:21				

* Excluded from averages because of contaminated plates.

This work shows that the figures obtained in all of the air investigations where conclusions are based upon results obtained by the plate-exposure method are not nearly so large as they should have been. The same criticism applies to some of the methods that have been suggested as a means of counting bacteria in air. One of the first to use this faulty principle of regarding bacteria-laden dust particles as equivalent to individual bacteria was Hesse.[25] He counted the colonies developing on gelatin after a measured volume, of air had been drawn over it in such a way as to catch the dust particles on the gelatin. The idea that the number of colonies developing on the surface of a solid medium after exposure to the air really represents the number of single bacteria deposited seems also to have been held by some of the later investigators, among them being Harrison,[26] Russell,[27] and Winslow.[28]

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[25] Hesse, W. Ueber quantitative Bestimmung der in der Luft enthaltenen Mikroorganismen. *Mitt. K. Gsndhtsamt.*, 2: 181–207, 1884.

CONCLUSIONS.

It seems reasonable to conclude that the nature of the filters tested had little influence on the results secured in duplicate analyses — that is, those obtained where a sand and a liquid filter were used side by side agreed just as well as those where either two sand filters or two liquid filters were used side by side.

It was found that the particular form of sand-filter aeroscope recommended by the Committee on Standard Methods for the Examination of Air varied in its filtering efficiency from 50 to 100 per ct., with the average efficiency for two series of tests of 90 and 91.6 per ct. The chief cause of error with this form of aeroscope arises from the fact that it is so constructed that it must be sterilized with steam. This causes caking of the layer of sand which acts as a filter.

A description is given of a modification of this form of aeroscope, so constructed that it may be sterilized with dry heat. The modified standard aeroscope was found to retain nearly 100 per ct. of the bacteria, with little chance of error. It was also found to be cheaper, less breakable, easier to operate, and more adaptable to field work than either the standard sand aeroscope or the aeroscope recommended by Rettger.

The latter can be made to yield excellent results, provided sufficient care is exercised in handling it. Its use, however, is attended with a number of difficulties, among which may be mentioned its tendency to leakage about the rubber stoppers after being sterilized, the foaming of the liquid during operation, and the tenacity with which the bacteria cling to the inner surface of the moist inlet tube.

The method of determining bacterial precipitation from air by means of exposed petri plates has been found to be entirely unreliable, as it gives a measure of the number of bacteria-laden dust particles and not a measure of the number of bacteria present. The number of bacteria precipitating upon a given area has been determined by analyzing measured quantities of sterile water which had been exposed to the air for a given length of time in sterile pails. The numbers obtained in this way were from 2 to 32 times as high as those obtained with the plate-exposure method.

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[26] Harrison, F. C. Report of the Bacteriologist. 22nd Ann. Report Ontario Agr. Coll. and Exp. Farm (1896). p. 105–116, 1897.

[27] Russell, H. L. Tainted or defective milks: their causes and methods of prevention. Wis. Agr. Exp. Sta., Bul. 62, 1897.

[28] Winslow, C.-E. A. A new method of enumerating bacteria in air. *Science*, N. S. 28:28–31, 1908.

PART II. STABLE AIR AS A SOURCE OF BACTERIA IN MILK.

INTRODUCTION.

With the technique devised and tested as already reported the investigation was continued in order to determine the importance of the stable air as a source of bacteria in milk.

To avoid misunderstanding it should be repeated that the present investigation has been made purely from the quantitative standpoint. Moreover, attention has been limited to a study of the contamination due to the general condition of the stable air; and no attention has been given to localized air contaminations that occur in milking due to dirt falling through the air from the cow's body. Many investigators have failed to make this important distinction.

PREVIOUS STUDIES.

For a long time it has been felt that air pollution is one of the important sources of difficulty in the production of clean milk. This conclusion has been supported by nearly all of the men who have made investigations in this field. The majority of these men have come to this conclusion by an indirect route and a careful reading of their papers shows that preconceived ideas of the prevalence of bacteria in the air and of the importance of air pollution (a legacy of the earlier work on spontaneous generation) have so influenced the conclusions drawn that they are sometimes directly contrary to the data given.

One of the commonly used methods for the study of this problem has been to select a number of cows, divide them into two groups, and test the milk of one group before some dusty barn operation (such as feeding hay or grain) and then the milk of the other group either during or after the barn operation under study. The most careful of these workers have carried on a series of such tests, alternating the two groups of animals in order to eliminate outside influences so far as possible. At the best, this is but an indirect method of attacking the problem, subject to many possibilities of error and useless, with our present methods of analysis, as a means of detecting small influences. Yet in many cases it has been the best available method and as such was used in some of the previous investigations at the Station.[29]

Another method of studying this problem has been to expose gelatin or agar plates in the stable during milking, feeding or other barn operation. Conclusions have been drawn concerning the effect of these operations in contaminating the milk from the number of colonies which have developed on the plates. As was shown in Part I (pages 174–7), the plate exposure method is an inadequate method of estimating the number of bacteria which are precipitated from the air, giving numbers which are much lower than the actual figures should be. Aside from this, the method is correct in principle. Almost all of the investigators who have used this technique have stopped with the determination of the number of colonies which develop on the plates after exposure and have not calculated from their data the number of bacteria per cubic centimeter which would have been added to the milk during exposure in the stable. If this had been done, none of the investigators would have given the impression that the air was quantitatively one of the most important sources of milk pollution.

Since the present writers have used methods of attacking this problem which makes it difficult to correlate their results with those secured by previous investigators in a more specific way than has just been done, no detailed review of this extensive literature will be undertaken.

PRESENT STUDIES.

A. TECHNIQUE.

As already indicated, an attempt has been made in this investigation to control all conditions which might influence the results and to measure the factor of air contamination as directly as possible. The work given in Part I and indirect data from various sources had led to the belief that the number of bacteria gaining access to the milk from the air was relatively small in comparison to the numbers derived from the interior of the udder, the exterior of the cow, and the pail. In devising methods of attack, it was therefore felt to be necessary to eliminate these factors if possible. Furthermore, it was thought advisable, so far as possible, to distinguish between contamination of the milk due to the washing effect of the milk as it is sprayed through the air during the milking process and the contamination of the milk due to precipitation of bacteria from the air into the opening of the milk pail. This distinction, although of little practical importance, has been found useful in our thinking on the subject.

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[29] See footnote 1, third reference.

In effecting this desired control, an apparatus was constructed which made it possible to imitate the milking process very closely and yet allowed the use of a sterile fluid in the place of milk as drawn from the udder. This latter substitution was considered essential as previous investigations[30] had shown that milk as drawn from the udder contains very variable numbers of bacteria. The liquid chosen for the present work was sterilized tap water which was drawn from the apparatus shown in Figure 4. In essence, this apparatus consisted of an artificial "udder" with two "teats" through which the sterilized water could be "milked" after the manner of actual milking, the whole apparatus being supported upon a platform of such a size as to give approximately the same protection as the body of the cow and at such a height from the milk pail as to give the same distances as occur in actual milking.

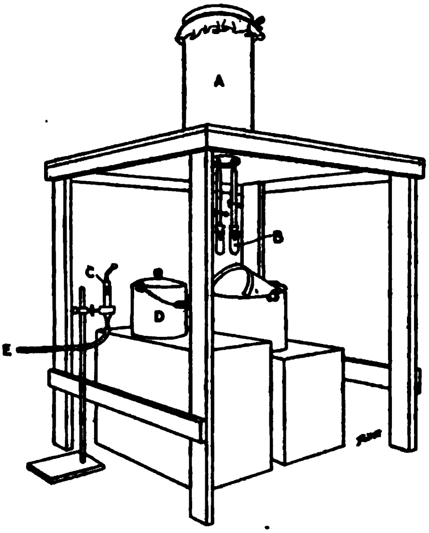

FIG 4.—APPARATUS USED IN ARTIFICIAL "MILKING."

A, "Udder." B, "Teats" protected by glass tubes. C, Aeroscope. D, Pail used in determining the amount of precipitation under the "cow". E, Connection to aspirator.

To describe the apparatus more specifically: The tin reservoir (A) was 18 inches in height and 7½ inches in diameter. Two holes were made in the bottom of this to which two tin tubes 3 inches in length were soldered. Fastened to the lower end of these tin tubes were rubber tubes which served to connect the former with a pair of glass "teats" (B). These "teats" were simply short pieces of glass tubing whose lower orifices had been flattened so as to spray the fluid "milked" in a manner similar to the effect produced in actual milking. In preparing this tin "udder" for sterilization, two thicknesses of a closely woven cheese cloth were tied over the opening at the top and the glass "teats" were protected by passing them through corks over which were fitted short test tubes which thus completely enclosed the "teats".

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[30] See footnote 1, fourth reference.

The "udder" thus far described was supported on a wooden platform in the center of which was an opening through which the "teats" could be passed. The platform was 26 inches square and 31 inches in height. In order to secure the usual distance between the milking pail and teats, the former was supported on a box underneath the platform. The milking pail used was a small hood-protected pail of the modified Loy type[31] having a capacity of about five liters. The opening was 4¾ by 6 inches. When standing upright, the exposed area was approximately 122 sq. cm. (18.9 sq. in.). During the experiments, the pails used (D) in order to determine the precipitation "under the cow" were placed directly beside the "milk pail" and at the same height. Those used for determining the precipitation in the open stable were placed on the floor near the apparatus just described.

In using this apparatus, four tests were made as nearly simultaneously as possible, two or three persons being kept busy attending to the various details of the tests: 1. The air was analysed after the manner described in Part I (see pages 424–7), using the modified standard aeroscope there described and figured. Usually seven liters of air were drawn through the aspirator in an interval of about five minutes. The aeroscope (C) was clamped in position underneath the platform just beside the two pails. 2. The process already referred to as simulating milking was carried on as described. The water was sterilized in a separate vessel and was carried to the barn in this vessel, there being poured into the "udder," after which the cheesecloth cover of the latter was replaced. Check samples were usually secured by drawing some of this water through one of the "teats" directly into sterile test tubes. Since this was done in a more or less dusty atmosphere, these check samples frequently showed some growth but this was never abundant enough to affect the conclusions drawn. All of the sterile water that could be "milked" in the time required for taking the air sample was drawn into the milk pail. The water in the milk pail was then sampled with a sterile pipette after thoroughly stirring it. This water contained the bacteria washed out of the air as well as those which had precipitated into the opening of the small mouthed pail. In order to apportion the number between each source, a third series of tests was made. 3. This consisted in exposing a pail (D) having an opening of 266 square centimeters area under the platform. Either 500 or 1,000 cubic centimeters of tap water was sterilized in the pail which was covered with an ordinary metal cover. Check samples were taken at the barn just before using and the cover was removed from the pail at the proper time. At the close of the milking interval the pail was re-covered and samples taken for analysis after thoroughly mixing the contents of the pail. 4. Similar determinations of the amount of precipitation in the open stable were made by placing pails on the floor beside the apparatus. The results secured from these pails are given in the tables under the heading of "precipitation in the open stable or loft."

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[31] See footnote 1, second reference.

The plating, incubation, and other analytical technique was carried out as in the previous part of the investigation (see pages 156–7). The plating of the samples was always completed within 1½ hours after the tests were made. Usually 1 cubic centimeter quantities were used in making plates and an agar to which 1 per ct. of lactose had been added was used. The counting and interpretation of plates were carried out as described in Part I. Plates were made in triplicate and the averages of the three plates accepted except where the plates were obviously overgrown or contaminated. In the matter of check plates which were always made, the same principles guided us in accepting or discarding results as in Part I. Contaminations and spreaders were more troublesome in this part of the work than in Part I due to the fact that the sampling had to be done under less favorable conditions. All results are given where a complete set of satisfactory plate counts were obtained in tests carried out simultaneously.

b. EXPERIMENTAL DATA.

A. NUMBER OF BACTERIA IN MILK DERIVED FROM THE AIR.

1. *Preliminary series of analyses in the stable.*—These were made to test the suggested technique. In this series the procedure used was slightly different from that described above and used later, but since the results secured were similar to those secured in the later tests they are included here. In this preliminary series, but one precipitation pail was used and that was placed on the floor beside the apparatus.

TABLE VIII.— TESTS MADE IN STATION STABLE DURING ARTIFICIAL "MILKING."
Made in the afternoon with the cows in the stable.

Test No.	Date.	Liters of fluid "milked."	Count per liter of air.	Precipitation on 1 sq. cm. in 5 min.		Germ content per c.c. in fluid "milked."		Barn operation in progress.
				Sample.	Check.	Sample.	Check.	
	1914							
1	Mar. 18	4.2	132	......	......	20	......	Feeding grain.
2	Mar. 18	4.2	78	......	......	9	......	Feeding grain.
3	Mar. 19	3.6	81	......	......	2	1	Feeding grain.
4	Mar. 19	2.2	122	......	......	5	1	Milking.
5	Mar. 19	3.1	78	......	......	3	1	Milking.
6	Mar. 20	2.2	93	......	......	10	1	Feeding grain.
7	Mar. 20	2.2	56	......	......	20	1	Milking.
8	Mar. 20	2.3	292	......	......	5	1	Milking.
9	Mar. 24	4.1	136	47	0	9	0	Feeding grain.
10	Mar. 24	3.3	187	28	0	7	0	Feeding grain.
11	Mar. 24	4.2	78	164	0	8	0	Milking.
12	Mar. 25	3.5	50	38	0	8	0	Feeding grain.
13	Mar. 25	?	70	19	0	?	0	Milking.
14	Mar. 25	3.4	52	190	0	2	0	Milking.
15	Mar. 31	2.2	114	79	0	73	2	Milking.
16	Mar. 31	2.2	760	51	5	16	5	Milking.
17	April 1	2.6	160	109	3	24	1	Milking.
18	April 2	2.2	478	208	2	51	2	Milking.
Ave. of all tests..		3.0	168	......	......	16	1	
Ave. of 9 complete tests.....		3.1	224	102	1	22	1	

In the first 14 tests, the water was allowed to flow continuously through the " teats " while in the later tests in the series and in all of the others made, the water was drawn intermittently thus imitating the actual milking process more closely. Tests showed that this change of procedure had little or no effect on the results secured.

Table VIII gives the results of the series of tests in detail. In 9 complete tests an average of 224 colonies developed per liter of air and 22 colonies developed per cubic centimeter of the water " milked." The latter contained both the bacteria washed out of the air by the milk sprayed through it and those which were precipitated into the open pail. One hundred and two colonies per square centimeter of surface developed from the bacteria precipitated in a five-minute interval into the open pail placed on the floor beside the apparatus. Knowing the number of bacteria precipitated per square centimeter, the area of the milk pail opening and the number of cubic centimeters of "milk," the number of bacteria precipitated into the "milk" was computed. This was found to be 4 per cubic centimeter. Subtracting this from the total number found in the "milk" (22 per cubic centimeter) gave 18 as the number of bacteria washed out of the air by the spraying of the "milk" through it.

TABLE IX.— TESTS MADE IN STATION STABLE DURING ARTIFICIAL "MILKING."
Made in the afternoon with the cows in the stable.

Test No.	Date.	*	Liters of fluid "milked."	Count per liter of air.	PRECIPITATION ON 1 SQ. CM. IN 5 MIN.		GERM CONTENT PER C.C. OF FLUID "MILKED."		Barn operation in progress.
					Open stable.	Under "cow."	Sample.	Check.	
	1914.								
1	April 16	4.0	3.3	134	......	54	36	1	Milking.
2	April 17	7.0	3.2	57	63	17	4	4	Brushing cows.
3	April 17	6.5	3.3	43	42	12	2	0	Feeding grain.
4	April 17	5.0	2.5	24	62	23	2	0	Milking.
5	April 22	5.0	2.4	40	109	100	51	2	Milking.
6	April 23	5.0	2.3	61	36	30	6	0	Feeding grain.
7	April 23	5.0	2.6	51	75	32	2	0.5	Milking.
8	April 23	5.0	3.6	50	49	28	5	2	Milking.
9	April 27	5.0	3.0	37	128	24	5	....	Milking.
10	April 28	4.5	2.5	61	81	52	7	1	Milking.
11	April 28	5.0	3.2	37	81	53	8	5	Milking.
12	April 28	4.5	3.4	183	94	67	9	1	Milking.
13	April 28	5.0	2.8	133	184	96	14	5	Feeding grain.
14	April 29	4.5	2.8	80	148	58	6	3	Milking.
15	April 30	5.0	3.3	117	269	66	12	1	Milking.
Average.........		5.1	2.9	74	102	47	11.3	1.7	

* Duration of "milking" in minutes.

2. *Second series of analyses in the cow stable.*— In this series of tests as in the previous series, all results were calculated on the basis of five minutes as the length of time required in "milking," this being approximately both the average time required in hand milking and the actual time used in making these artificial tests. Results of the tests are given in Table IX. In the 15 tests, an average of 74 colonies developed per liter of air, 11.3 bacteria per cubic centimeter were added to the "milk" from the air by the milking process; 47 bacteria were precipitated per square centimeter under the "cow" and 102 bacteria per square centimeter were precipitated into the pail in the open stable. When these 11.3 bacteria per cubic centimeter of milk are divided between those washed out

of the air by the streams of " milk " and those added by precipitation into the pail, as was done in the previous series, the figures become 9.6 and 1.7 bacteria per cubic centimeter respectively.

TABLE X.— TESTS MADE IN STATION STABLE DURING ARTIFICIAL " MILKING."
Made in the morning while the cows were being fed chopped hay.

Test No.	Date.	Duration of " milking " in minutes.	Liters of fluid " milked."	Count per liter of air.	PRECIPITATION ON 1 SQ. CM. IN 5 MIN.		GERM CONTENT PER C.C. OF FLUID " MILKED."	
					Open stable.	[1] Under " cow."	Sample.	Check.
	1914.							
1..........	May 6	5.0	4.0	153	107	130	10	1
2..........	May 6	5.0	4.5	117	58	28	6	1
3..........	May 6	5.0	4.5	137	83	58	11	1
4..........	May 6	5.0	3.8	84	8	30	7	1
5..........	May 7	4.5	3.0	87	111	84	22	1
6..........	May 7	6.0	4.0	56	23	28	3	1
7..........	May 7	5.0	3.7	14	15	15	4	2
8..........	May 7	5.0	3.0	27	26	21	3	2
9..........	May 8	5.5	5.6	49	50	34	4	2
10..........	May 8	5.0	4.1	27	32	41	2	4
11..........	May 9	5.5	5.3	41	132	14	1	0
12..........	May 9	5.0	4.5	53	21	56	3	0
13..........	May 9	5.5	4.0	53	21	15	8	1
14..........	May 12	4.5	3.8	133	?	92	20	1
15..........	May 12	4.0	3.7	61	52	19	6	0
16..........	May 12	5.1	4.1	44	9	90	4	1
Averages............		5.0	4.1	71	50	47	7	1

3. *Analyses made in a stable where the cows were being fed dusty chopped hay.*— The very low results secured up to this time in the investigation were surprising to the investigators. It was therefore decided to make a series of tests under very dusty conditions. At this season of the year the cattle were being fed chopped dry hay which caused a heavy dust in the stable at the time it was fed. Tests were therefore made while the feeding was taking place, four tests being made each day. The apparatus for making the tests was set up in the alley-way in front of the cows where the dust was the thickest. Altogether 29 sets of analyses were made but only 16 sets proved to be entirely satisfactory. Only these latter are given in detail in Table X. The inclusion of all of the data, however, would not have changed the conclusions.

An average of 71 colonies developed per liter of air in the 16 tests. and the number of colonies obtained per cubic centimeter of the " milk " was only 7.0. This number is again so low that the possible error due to contaminations is proportionately large, though the actual amount of contamination is necessarily very small, if any took place. Forty-seven colonies developed per square centimeter of the area exposed in the pail placed under the platform while 50 colonies developed for each square centimeter of the pail placed in the open beside the apparatus.

When the number found in the "milk" (7.0 per cubic centimeter) is divided between the two sources already mentioned, it is found that probably 1.4 bacteria per cubic centimeter were precipitated into the milking pail and that 5.6 per cubic centimeter were washed out of the air. Such low figures were again a great surprise to the investigators and show that either the dust from this lot of hay could not have been richly laden with bacteria or that the dust settled so rapidly that it did not materially affect the normal state of the air in the stable.

4. *A series of analyses carried out in the stable loft.*— The fourth series of analyses differed from the others in several particulars. Thus far none of the work had been done in an air richly laden with bacteria in spite of the fact that the trials had been conducted under a great variety of conditions and under many of the normal conditions which might be expected in a dairy stable. In order to get an air richly filled with bacteria, it was therefore decided to conduct the next series of analyses in the hay loft where a heavy dust could be secured by stirring up the mixture of hay, chaff, dirt and the like on the floor. At the time the tests were made, this was stirred up until the condition of dustiness was much greater than that ordinarily found in dairy stables even when dry grain or hay is being fed. The dustiness was so great that it was decidedly disagreeable to work in the loft. Since both investigators were needed to make the various tests, the dust was only raised once and that at the beginning of each test.

Four tests were made on each day, and the time of "milking" was made five minutes in each case. Owing to the greatly increased number of bacteria present, it was necessary to increase the amount of sterile water in the precipitation pails from 500 to 1,000 cubic centimeters and to use 100 cubic centimeters of sterile water in plating out the sand from the aeroscope. The rest of the technique remained the same. The results of 24 satisfactory tests, out of 30 made, are given in Table XI, six results being omitted because the check plates did not prove satisfactory or because of incomplete results due to spreading colonies and to mold growths.

TABLE XI.— TESTS MADE IN CONNECTION WITH ARTIFICIAL "MILKING" IN STABLE LOFT.

Dense dust raised just before each test from the hay and dirt on floor.

Test No.	Date.	Liters of fluid "milked."	Count per liter of air.	Precipitation on 1 Sq. Cm. in 5 Minutes.		Germ Content per C.C. of Fluid "Milked."		
				Open loft.	Under "cow."	Sample.	Check.	Difference
	1914.							
1..........	July 8	5.0	3,160	327	188	40	6	34
2..........	July 8	4.4	1,886	184	124	26	10	16
3..........	July 8	4.1	6,343	......	552	133	27	106
4..........	July 9	5.1	1,600	666	666	58	12	46
5..........	July 9	5.1	3,945	564	353	80	23	57
6..........	July 9	4.9	5,200	564	346	99	37	62
7..........	July 10	4.4	1,370	549	259	77	8	69
8..........	July 10	3.9	1,400	......	1,376	74	23	51
9..........	July 10	3.5	1,130	414	237	39	6	33
10..........	July 11	5.2	2,357	647	361	56	5	51
11..........	July 11	4.9	1,570	......	545	77	7	70
12..........	July 11	5.4	1,557	556	316	62	17	45
13..........	July 11	4.4	1,300	714	274	50	2	48
14..........	July 13	3.9	1,429	320	173	23	6	17
15..........	July 13	5.1	2,043	402	308	43	7	36
16..........	July 13	4.7	2,629	459	180	53	8	45
17..........	July 14	4.0	329	207	135	14	9	5
18..........	July 14	4.1	514	......	459	93	5	88
19..........	July 14	4.9	900	417	211	59	8	51
20..........	July 14	4.6	1,828	1,492	436	61	20	41
21..........	July 15	4.6	1,370	740	346	44	10	34
22..........	July 15	4.6	1,685	767	240	50	2	48
23..........	July 16	5.4	2,370	1,019	451	60	12	48
24..........	July 16	5.1	1,714	2,557	368	45	4	41
Averages............		4.6	2,068	*678	371	59	11.4	47.6

* Only 20 tests in this average.

The number of colonies developing from the air proved to be high, the average for the 24 tests being 2,068 per liter. Yet when the "milk" was analysed only 47.6 colonies appeared per cubic centimeter The number of colonies which developed from the bacteria precipitated per square centimeter of the pail placed under the platform was 371, while the number for the pail placed outside was 678 per square centimeter. When the number of bacteria which were precipitated into the "milk" was calculated as explained above (p. 184), it was found that probably 9.8 bacteria per cubic centimeter had fallen into the pail leaving 37.8 bacteria per cubic centimeter as the number which had been washed out of the air.

In one respect, the figures secured were not satisfactory. As shown in Table XI, the check plates made from the "milk" drawn directly into sterile test tubes were never entirely sterile. Later work showed that the trouble was due to dust which either clung to the moist tips of the teats or got into the test tubes as they were opened to draw the samples. Since the amount of this contamination does not change the conclusions drawn, the results have been given as shown in the table.

There is a certain general agreement in results which is worth noting. The greatest number of bacteria appeared in the "milk" in the test (No. 3) where the aeroscope showed the largest number of bacteria present in the air. Likewise the lowest number appeared in the "milk" in the test (No. 17) where the aeroscope showed the fewest bacteria in the air. Intermediate results show many similar relations though exact ratios do not occur nor are they to be expected. In general no widely discordant results occur in this or in any of the preceding series.

5. *Analyses made in the stable loft.* — Although the dust maintained in the previous series of analyses was so dense as to be disagreeable to work in and as such was heavier than the dust to be found in any cow stable under ordinary conditions, it was decided to carry the work still further. This was the more desirable because in the meanwhile an analysis of the air in a stable of a barn in the vicinity had been obtained, in which the number of bacteria present was greater than any of the numbers given in Table XI. (See Table XVII, Barn A, Test No. 8, page 201.) In this new series, extraordinary pains were taken to secure sterile check plates from the "milk" drawn from the "udder." Twenty-four preliminary tests were made before the proper dilutions to use were discovered and methods of drawing samples were devised. The number of tests made per day was reduced from four to two and finally to one before the proper precautions could be carried out. Of the final series of twenty-two tests there were still two which were discarded because of bad check plates.

During the course of these preliminary tests, it was discovered that dust clung to the inner surface of the inlet tube of the aeroscopes even where these were perfectly dry. Several tests were therefore made in order to find out whether this loss was important or not, and also to check up duplicate analyses under these exceptional conditions. In testing to determine the amount of loss due to the dust clinging to the inlet tubes, 24 comparisons were made between aeroscopes of the usual construction and aeroscopes in which the top was left open; that is, the aeroscopes were sterilized with a cotton plug in the open end which was removed just as the test was started. The results of these tests showed an average of 12,628 colonies per liter for the aeroscopes with the standard inlet tubes as against 21,733 colonies per liter for those in which the top was left open. This result showed clearly that the standard form of inlet tube retained some bacteria, making all of the per liter figures given in Table XII too low. Yet because of the fact that much of the increase in number of bacteria in the open aeroscopes was due to free precipitation into the open end, it was decided to continue to use the standard inlet tube thus giving comparable results throughout the whole work.

In 40 comparisons made between two aeroscopes of the usual construction the average results secured were 14,376 colonies per liter of air for one sample and 14,882 for the duplicate. Individual comparisons did not always check as well as the averages did, but in general the results were more satisfactory than those secured in the analyses recorded in Tables V and VI in Part I (pages 171 and 173). Since some of these duplicate analyses were run at the same time as the other tests whose results are given in Table XII, the per liter figures given in this table are the average of the two analyses in some cases (indicated with an asterisk).

Fearing also that the method of measuring bacterial precipitation in use might not give satisfactory results under these very dusty conditions, four of these tests were made in duplicate. The results gave an average of 3,645 colonies per square centimeter in a five-minute interval for one sample and 4,455 for the duplicate. Individual results also checked well so that no change in the technique was made.

The dust was maintained continuously during the testing in each case. To do this required three persons working simultaneously, two men, as before, attending to the details of "milking," exposing the precipitation pails and the like, while the third man took care of the aeroscopes and kept the dust stirred up.

Table XII gives the detailed results of the 20 satisfactory tests which were carried out and also the averages of the total 46 tests. The average numbers of bacteria found per liter of air in these tests was high (9,575 and 9,182). The lowest result obtained was 960 per liter while the two highest results were 28,200 and 71,500 bacteria per liter. The latter figures are the highest obtained at any time in the investigation. Enormous numbers of bacteria fell into the precipitation pails as is shown by the results given in columns five and six. The average numbers found for the pail placed in the open loft were 28,377 and 41,855 per square centimeter in a five minute exposure. The similar figures for the pail placed under the platform were 14,163 and 20,774. In general there is a correspondence between the amount of precipitation and the number of bacteria found floating in the air but this relation is not a constant one.

TABLE XII.— TESTS MADE DURING ARTIFICIAL " MILKING " IN THE STABLE LOFT.
Dense dust raised and maintained during the tests.

Test No.	Date.	Liters of fluid " milked."	Count per liter of air.	PRECIPITATION ON 1 SQ. CM. IN 5 MIN.		GERM CONTENT PER C.C. OF FLUID " MILKED."	
				Open loft.	Under "cow."	Sample.	Check.
	1915.						
1	April 16	5.0	960	560	900	69	2.7
2	April 16	5.0	1,643	9,870	4,870	161	8.0
3	April 19	4.5	7,000	16,383	8,809	629	4.0
4	April 19	4.0	9,710	13,912	10,403	620	4.0
5	April 22	5.0	1,186	8,491	1,128	135	3.0
6	April 22	5.0	4,286	22,560	5,114	118	8.3
7	April 23	5.0	1,800	19,550	9,626	301	6.0
8	April 23	5.0	7,570	65,048	7,820	420	1.0
9	May 13	5.0	5,817	35,720	10,265	550	1.7
10	May 14	5.0	*2,673	15,300	3,570	236	2.7
11	May 17	5.0	*28,200	64,672	27,072	1,430	0.3
12	May 18	4.5	*16,600	39,689	26,320	1,078	1.0
13	May 19	5.0	*26,110	53,580	42,770	1,200	1.0
14	May 20	5.0	*12,700	4,550	5,076	252	1.0
15	May 21	5.0	*13,100	25,485	26,320	1,000	0.3
16	May 22	5.0	*18,500	72,568	25,944	780	0.0
17	May 26	5.0	*6,420	12,617	14,246	767	1.3
18	May 27	5.0	*15,300	20,050	18,800	822	1.0
19	May 28	4.2	*7,700	33,840	16,544	690	0.3
20	May 29	4.5	*4,230	33,088	17,670	820	0.3
Averages of 20 satisfactory tests		4.8	9,575	28,377	14,163	604	2.4
Averages of total 46 tests		4.6	9,182	41,855	20,774	745	

* This number is the average of two duplicate analyses.

The most interesting figures are those which were obtained from the " milk." As shown in the last column, the check plates obtained in the case of the 20 tests given in detail were satisfactory when the conditions of work are considered. Under these very dusty conditions the " milk " gave an average of 604 bacteria per cubic centimeter in the 20 tests with satisfactory check plates or 745 per cubic centimeter when all of the data was included. The highest number of bacteria found in the series of 20 tests was 1,430 per cubic centimeter (Test No. 11) while the lowest number was 69 (Test No. 1). These numbers were obtained when the number of bacteria floating in the air were the highest and the lowest respectively. In a general way the counts obtained from the "milk" and those obtained from the air parallel each other fairly well though exceptions do occur.

When the bacteria per cubic centimeter of fluid "milked" (604) are divided into those precipitated from the air and those washed into the pail by the milk streams (see p. 183), the results become 357 and 247 per cubic centimeter respectively. In one respect, the results of this series of tests differed from those of the four preceding series. Here the dust was so heavy that it precipitated more rapidly and completely than in the earlier tests and as a result a greater proportion of the bacteria which appeared in the "milk" were due to precipitation than in the previous tests.

5. *Discussion of results of five preceding series of tests.*— The results recorded in the five preceding series of tests have already been briefly described but there are several important conclusions which can be pointed out from the five series as a whole. Altogether, 110 complete sets of analyses have been made under a variety of conditions, the number of bacteria varying from 14 per liter to 71,500 per liter of air. The highest bacterial count per liter of air in the Station stable obtained in the five series of tests was 760.

In all of the analyses made in the Station stable, the number of bacteria appearing in the liquid "milked," was surprisingly low (average=12), in fact much lower than had been expected. The highest count obtained under these conditions was 73 per cubic centimeter. Then follow in order, 51, 51, and 36. All the remaining analyses gave counts of less than 22 per cubic centimeter, figures which are so low that accurate counts are difficult to obtain because of relatively large errors produced by small contaminations. The low germ content thus secured shows that air contamination of this sort is insignificant under good dairy conditions.

In those analyses made in the stable loft under abnormally dusty conditions, the germ content per cubic centimeter of the fluid "milked," ranged from 14 to 2,134. When the dust was raised but once the highest germ content obtained was 133 per cubic centimeter while the lowest count obtained when the dust was maintained continuously, was 69 per cubic centimeter. These numbers were secured under very dusty conditions. Contaminations as bad as the worst of these could easily be detected by ordinary laboratory methods.

The above data may be presented in another way as shown in Table XIII which gives a summary of the data recorded in Tables VIII to XII according to the number of bacteria found per liter of air. In the 26 tests which were made when the number of bacteria present in the air was less than 100 per liter, the average germ content of the "milk" was 7.0 per cubic centimeter. In the 19 tests made when the number of bacteria was between 100 and 1,000 per liter of air, the average germ content of the "milk" was 33.4 per cubic centimeter. In the 33 tests when the number of bacteria in the air was between 1,000 and 10,000 per liter of air, the average germ content of the "milk" was 195, while in the 7 tests when the number of bacteria was over 10,000 per liter of air, the average germ content was 937 per cubic centimeter. Since in the Station stable the number of bacteria per liter of air is rarely above 500, this source of milk contamination must necessarily be small at all times. In some commercial dairies, where dustier conditions prevail it would be a factor of sufficient importance to warrant an effort to reduce dust-producing operations during milking to a minimum.

TABLE XIII.— ANALYSES SUMMARIZED ACCORDING TO THE NUMBER OF BACTERIA PER LITER OF AIR.

GERM CONTENT PER LITER OF AIR BETWEEN —	Number of tests made.	Average count per liter of air.	AVERAGE PRECIPITATION IN 5 MINUTES.		Bacteria washed out of air by "milk" stream.	Total germ content* in "milk"
			Per sq. cm. under "cow."	Per c.c. of fluid "milked."		
0–100	26	51	49	1.8	5.2	7.0
101–1,000	19	312	210	6.6	26.6	33.2
1,001–10,000	33	3,270	3,581	94.0	101.0	195.0
10,000 and upwards	7	18,644	24,264	611.0	326.0	937.0

* The figures in this column are the sum of those in two preceding columns.

All of the results obtained in this investigation have been summarized according to various barn operations in order to discover whether there was any relation between particular barn operations and the number of bacteria in the air. Altogether 1,130 separate analyses of air samples have been made in this work but since many of them were duplicate analyses or were made under artificial conditions they are not available for this summary. Three hundred and forty-four analyses were made, however, under normal barn conditions, and in such a way that the results are available for this purpose. These have all been summarized in Table XIV according to nine different barn operations. Not all of these analyses were made with the same kind of an aeroscope, and a small percentage of the results are undoubtedly lower than they would have been if the technique finally adopted had been used. This is offset by the fact that wherever duplicate analyses were available, only the higher results were used in the summary.

TABLE XIV.— ANALYSES SUMMARIZED ACCORDING TO THE BARN OPERATION IN PROGRESS AT THE TIME OF MAKING THE ANALYSIS.

BARN OPERATION IN PROGRESS AT THE TIME THE ANALYSIS WAS MADE.	Number of analyses made.	Average germ content per liter of air.
1. Barn empty everything quiet	60	41
2. Barn empty, sweeping floor or dusting off stanchions	7	135
3. Cows in barn. Everything quiet	20	94
4. Brushing off cows	33	130
5. Feeding dry grain	50	124
6. Brushing off cows when test was started. Feeding grain at end of test	8	190
7. Feeding grain at beginning of test. Milking started before test was finished	11	235
8. Milking in progress	153	111
9. Feeding silage just after milking was finished	10	271

The average germ content per liter in all of the 344 tests was 115. The lowest number of bacteria was found, as would naturally be expected, when the barn was empty and the air was quiet. In sixty such analyses the average number of bacteria found was 41 per liter of air. In 20 analyses made when the cows were in the barn but standing or lying quietly and all was quiet in the stable, the number of bacteria found was 94 per liter of air. During the milking period when everything was as quiet as could be expected under these circumstances, 153 analyses showed an average of 111 bacteria per liter.

In the periods when barn operations were in progress which caused more or less dust, a gradual increase in the number of germs present is found. Thus 50 analyses taken at the time when dry grain was being fed to the cows gave 124 colonies per liter of air, 33 analyses taken while the cows were being brushed gave 130 colonies per liter of air, and 7 analyses taken while the empty barn was being swept and the stanchions brushed off gave 135 bacteria per liter of air. Eight tests taken just at the time when brushing of the cows was still in progress and the feeding of dry grain had started showed 190 bacteria per liter. Eleven analyses were taken just as the cows finished eating the dry grain and milking was starting. These showed an average of 235 bacteria per liter. The highest average numbers were found after milking was finished and at the time when the cows were being fed silage. At this time the cattle were moving about in their stalls causing considerable commotion and dust and it is believed that this caused the high counts rather than bacteria from the silage. The average number of bacteria found in 10 such tests was 271 per liter of air.

Individual tests among the 344 analyses gave results varying from 0 to 825 colonies per liter of air. Individual tests made while milking was actually in progress varied from 4 to 760 colonies per liter. About one-third of the tests gave results under 50 colonies per liter, about one-third between 50 and 100 per liter and the remaining third gave more than 100 per liter.

These results obtained in the Station barn are similar to those of Leufven [32] who obtained numbers of bacteria ranging from 178 per liter before work commenced in the cow stable to 504 per liter during the feeding of hay. During milking, he found 184 bacteria per liter and 193 per liter just at the close of milking. The analyses were made by the use of aeroscopes which contained powdered sugar filters.

Barthel,[33] using aeroscopes with filters of powdered sodium sulphate, obtained an average of 52 microorganisms per liter in the open air, 112 per liter in the stable during the noon hour and 740 per liter during the feeding of hay. In another series of tests, he obtained 300 microorganisms per liter during the midday rest, 315 per liter during the evening milking and 1,213 per liter during the feeding of hay. He also cites (page 626) the work of Lönnroth who, he says, used the same technique and obtained results somewhat higher than his own. In comparing these figures with those given in this Bulletin, it should be kept in mind that the figures which Barthel has given include both bacteria and molds.

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[32] Leufvén, G. J. Undersökningar inom Ultuna mejeri och ladugård. f2. Luftundersökningar inom mejeret och ladugården. *Redögorelse för Versamheten vid Ultuna Landtbruksinstitut, Landtbruksskola och Egendom år 1894*, p. 35–46, 1895.

[33] Barthel, C. Untersuchungen über die Mikroorganismen in der Stallluft, in der frischgemolkenen Milch und im Euter der Kuh. *Milchzeit.*, 32:626–628, 645–647, 658–660, 1903. Idem in French, *Rev. Gen. du Lait*, 1:505–516, 529–541, 1902.

Petri[34] has likewise given us some analyses of stable air which he made with the aid of his newly devised sand filter. His results vary from 8.5 to 34 bacteria per liter of air. Koning[35] also gives six analyses which were made with a sand filter. His results vary from 15 to 720 bacteria per liter, the former being made in the open air and the latter between two cows in a stable.

B. DISCUSSION OF THE RESULTS OBTAINED BY EXPOSING A STERILE FLUID IN PAILS TO THE AIR OF THE STATION STABLE.

One of the dairy operations commonly advocated for the production of a clean milk is the prompt removal of the milk from the stable as soon as drawn. It therefore becomes important to measure the value of this procedure. This has been done, as already explained (page 182) by exposing pails containing a known amount of sterilized water in the stable for known periods of time. Since this determination was made at the same time that the air was being analysed and other tests were being carried out, all of the detailed data has been tabulated together. (See Tables VIII to XII.) The data which apply to the subject under discussion here have been given in these tables under the heading "precipitation in the open stable or loft."

Fifty-four of these tests, which were made in the Station stable, have been retabulated in summarized form in Table XV according to the barn operation in progress at the time the test was made. In the same table the average number of colonies which developed from the bacteria which fell on a one-square-centimeter area in a five-minute interval, has been converted by calculation into the number of colonies which would develop from each cubic centimeter of milk in a five-liter (about five quarts) pail of milk if exposed for the interval of time given (1, 5, 15, 30 or 60 minutes). The calculations have been made for both the small-mouthed (Loy) pail with an area of opening of 142 square centimeters and the open 12-inch pail which has an area of opening of 729 square centimeters.

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[34] See footnote 3.
[35] See footnote 17.

TABLE XV.— RESULTS OBTAINED BY EXPOSING A STERILE LIQUID IN PAILS TO THE AIR OF THE OPEN STABLE.

Summarised according to the barn operation in progress at the time the test was made.

BARN OPERATION	Pail.	Number of tests.	Precipitation on 1 sq. cm. in 5 min.	CALCULATED NUMBER OF BACTERIA WHICH WOULD BE ADDED TO THE MILK PER C.C. IN				
				1 min.	5 min.	15 min.	30 min.	60 min.
Feeding dry grain	Loy....	7	71	0.40	2.02	6.05	12.1	24.2
	Open...	7	71	2.07	10.35	31.05	62.1	124.0
Feeding dry chopped hay.	Loy....	22	55	0.30	1.56	4.69	9.4	18.7
	Open...	22	55	1.60	8.02	24.06	48.0	96.0
Milking.........	Loy....	25	114	0.6	3.20	9.60	19.2	38.0
	Open...	25	114	3.3	16.6	49.8	99.6	199.0

Table XVI shows similar data except that the numbers of bacteria which would be added to the milk from standing in the stable are derived from arbitrarily assumed numbers of bacteria precipitating on a given area (see first column of Table XVI). The table was drawn up for the purpose of furnishing a ready means of making comparisons.

As shown in Table XV, seven tests made in the Station stable while the cows were being fed dry grain showed an average of 71 colonies developing on the agar plates for each square centimeter of exposed surface, this and all the remaining data of the same kind being calculated on the basis of a five-minute exposure. Twenty-two similar tests made in the Station stable at a period when the cows were being fed dry chopped hay gave the surprisingly low result of 55 colonies per square centimeter of area. Somewhat higher results were obtained from 25 tests made during milking although the dust in the air was less noticeable than during either of the two operations just mentioned. The average in the last case was 114 colonies per square centimeter.

In order to show the effect which this amount of precipitation would have on the germ content of the milk produced in the stable, it is necessary to recalculate this data in such a way as to show the increase which would take place in the germ content per cubic centimeter of an average pail of milk if it were allowed to stand in the open stable. This has been done and the results are given in the last five columns of the table. In this calculation, the average quantity of milk per cow has been arbitrarily taken at five liters. The results of this calculation show that under the worst of the assumed conditions, namely, where the milk is allowed to stand an hour in the open stable in an open 12-inch pail, the number of bacteria added per cubic centimeter would be 124 if this were done while the cows were being fed dry grain, 96 if this were done while they were being fed dry chopped hay or 199 if it were done during milking. These numbers are all so small that they could scarcely be detected in any but the highest grade of milk by any known method of analysis. An examination of the results calculated on the basis of a small-mouthed pail shows that a five-quart pail of milk could stand in the open stable for one hour or longer without producing any detectable result so far as bacteria added to the milk from the air are concerned. Numbers could also be calculated in a similar way which would show the effect of exposing milk in open milk cans or in strainers.

As shown in Table XVI, when the number of bacteria which are precipitated into the open milk pail is between 50 and 100 per square centimeter in a five-minute exposure, the number of bacteria which would be added to a five-liter pail of milk in an exposure of one hour is small (87–180 per cubic centimeter). Such an increase in numbers could probably be detected in a very high grade milk by present methods of bacteriological analyses but could not be detected in a milk containing 10,000 or more bacteria. If the number of bacteria precipitating per square centimeter in a five-minute interval should be as great as 500–1,000, the number of bacteria added to a five-liter pail of milk in a 15-minute exposure (219–437) could be detected as stated before in very high grade milks but probably not in milk containing more than 10,000 bacteria per cubic centimeter. As shown in the table, when the number of precipitating bacteria becomes larger than those just discussed, even a very short exposure of the milk suffices to produce appreciable increases in the number of bacteria which would occur in the milk. Because of the much smaller opening of the pail, the number of bacteria which would fall into the small-mouthed pail is about one-fifth of the number which would fall into the open pail.

TABLE XVI.— CALCULATED NUMBER OF BACTERIA WHICH WOULD FALL INTO AN OPEN MILK PAIL IN GIVEN LENGTHS OF TIME

ASSUMED PRECIPITATION ON 1 SQUARE CENTIMETER IN 5 MINUTES.	CALCULATED NUMBER OF BACTERIA WHICH WOULD BE ADDED TO THE MILK PER CUBIC CENTIMETER IN				
	1 minute.	5 minutes.	15 minutes.	30 minutes.	60 minutes.
50	1.5	7.3	21.9	43.7	87.5
100	2.9	14.6	43.7	87.5	180
250	7.3	36.5	109	218	437
500	14.6	72.9	219	437	875
1,000	29.2	146	437	875	1,750
5,000	146	729	2,187	4,374	8,748
10,000	292	1,458	4,374	8,748	17,496
50,000	1,460	7,290	21,870	43,740	87,480

The interpretation of these results on the basis of actual farm conditions is not difficult. In the Station stable there were only 17 out of a total of 54 tests in which the number of precipitating bacteria was greater than 100 per square centimeter in a five-minute interval, the highest test showing 269 bacteria precipitating per square centimeter. Many of these tests were made while dry, chopped hay or dry grain was being fed and all were made when there was more or less commotion in the stable such as that produced during milking, feeding silage, brushing cows and the like. Even during the worst of these conditions a pail of milk could have stood for 15 minutes in the open stable without detectable result so far as increase in the number of bacteria was concerned.

Because even the worst of the conditions tested in the Station stable did not represent the worst known or worst conceivable conditions in commercial dairies, 66 tests were made in the barn loft where heavy dusts were readily obtainable. As has been stated in connection with the previous discussion, some of these results (Table XI, page 187) were obtained after raising an abundant dust at the beginning of each test while some were obtained while a continuous dust was being stirred up (Table XII, page 190). In the first of these two series, which included 20 tests, an average of 678 colonies developed for each square centimeter of area exposed for five minutes. In this case, the lowest numbers (tests Nos. 2 and 17, Table XI) obtained, were lower than some of the highest tests obtained in the stable (see tests Nos. 14 and 18, Table VIII and tests Nos. 13 and 15, Table IX) but the highest results obtained were very high.

In the second of the two series of tests carried out in the loft (Table XII), 46 tests gave an average of 41,855 colonies developing from the bacteria which fell on each square centimeter in a five-minute interval, the lowest test showing 560 and the highest 291,400. However, if only the 20 more satisfactory tests are taken into account the average becomes 28,377 and the highest individual test 65,048.

The medium and lowest results obtained in these two series of tests represent conditions which might obtain in any barn for a short time after such dusty barn operations as feeding dry hay, grain and the like. If milk were exposed in the stable under such conditions for a short time only (see Table XVI) the numbers of bacteria added would be appreciable while these numbers rapidly increase with longer exposures or with worse conditions. The highest of the results obtained from precipitation in the loft represent conditions which are scarcely conceivable even in the worst commercial dairies. They could only be obtained by attempting to milk within a few feet of the dusty end of a threshing machine or the like. The precipitation pails exposed under these conditions were covered with a heavy layer of dirt at the end of five minutes.

C. ANALYSES OF THE STABLE AIR OF COMMERCIAL DAIRIES.

Because of the fact that the Station stable presents some unusual conditions, it was deemed wise to carry the investigation into commercial dairy stables where the conditions were in no way exceptional. However, in doing this it was not practicable to make as complete comparisons as in the former case. Accordingly, analyses which showed the number of bacteria present in the stable air of three dairy barns in the immediate vicinity were made. One of these (Barn C) was a barn of the old type and would be given a low rating on any dairy score card. In fact, in the investigation reported upon in Bulletin 398,[36] this dairy is referred to as Farm 31 and is given a score of 48.95, on the "Official" card, 42 on the New York City card and 53.2 on the "Cornell" card. The other two barns (Barns A and B) were modern in construction and of a fairly good type. They are referred to in Bulletin 398 as Farms 16 and 18. The dairy scores there given them are 73.08 and 66.10 on the "Official" card, 73 and 58 on the New York City card and 81.4 and 73 on the "Cornell" card.

Barn A. The air of this barn was sampled fifteen times, five times in the summer (by K.) and ten times in the winter (by R.). The barn was fitted with swing stanchions and had a concrete floor and drop. The interior was well lighted. The walls were free from cobwebs and there was little dust on the ledges. The air was noticeably dusty on both visits to the stable. Eighteen cows were kept. While they were free from dried manure on their flanks, it was evident that no especial care was taken to clean them.

Seven-liter samples of air taken for each test and the aeroscopes were brought to the laboratory at once and the material plated in the usual manner. Because of uncertainty as to the number of bacteria present a larger number of dilutions was made than usual. The results of the tests are given in Table XVII together with notes which tell the barn operation in progress at the time the analysis was made. The hay referred to as being fed at the time of the July visit was cured cowpeas and oats. The results of the five analyses made under these conditions varied from 106 to 227 colonies per liter of air. Such figures show a close correspondence to the figures secured in the Station stable under similar conditions. The tests made in the winter time were made under a greater variety of conditions and show much greater variations in results. The highest number (16,070) was the highest number secured in any of the commercial dairies and was obtained while hay was being thrown down and fed to the cows. Other relatively high results were secured immediately after this, which would correspond to the lowest of the results secured in the Station loft when an artificial dust was raised. In half an hour the dust had settled to such an extent that the number of colonies developing per liter of air had become much lower. One abnormally low result was secured (Test No. 14, four colonies per liter) which is so low as to suggest possible leakage in the aspirator connections and yet results as low as this were obtained under some conditions in the Station stable. This series of tests is important as it shows what may be regarded as the extreme range of bacterial counts in the air of commercial dairy stables.

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[36] Brew, J. D. Milk quality as determined by present dairy score cards. N. Y. Agr. Exp. Sta., Bul. 398, 1915.

Barn B. This was a more recently constructed barn than Barn A. but was not as well kept. The 39 cows stabled here were not brushed and were covered with dust. Some had dried manure clinging to their flanks. At the time of the two visits made during the winter time the floor was covered with ground rock phosphate which was used as an absorbent. The bedding was of straw. Dry feed was given the cows after milking and the air was not noticeably dusty. One visit was made to this barn in July (K.), one in January (R.) and one in March (R.).

The summer tests which were taken just before and during milking showed bacterial counts between 31 and 116 per liter of air. The winter tests again showed a greater range varying from 14 to 841 per liter of air. None of these results were markedly different from those obtained in the Station stable.

TABLE XVII.— ANALYSES OF STABLE AIR IN BARNS IN THE NEIGHBORHOOD OF THE EXPERIMENT STATION.

	Test No.	Date.	Germ content per liter of air.	BARN OPERATION IN PROGRESS AT TIME OF MAKING ANALYSIS.
Barn A	1.....	July 31, 1914	227	Milking. Cows eating dry hay. Air dusty.
	2.....	July 31, 1914	106	Same as above.
	3.....	July 31, 1914	189	Same as above.
	4.....	July 31, 1914	117	Same as above.
	5.....	July 31, 1914	160	Same as above.
	6.....	Mar. 19, 1915	276	Before milking. Cows in barn.
	7.....	Mar. 19, 1915	857	Before milking. Throwing down hay and feeding.
	8.....	Mar. 19, 1915	16,070	Before milking. Throwing down hay and feeding.
	9.....	Mar. 19, 1915	686	Before milking. Throwing down hay and feeding.
	10.....	Mar. 19, 1915	1,100	Milking (25 minutes after test No. 6).
	11.....	Mar. 19, 1915	563	Milking.
	12.....	Mar. 19, 1915	677	Milking.
	13.....	Mar. 19, 1915	404	Milking.
	14.....	Mar. 19, 1915	4	Milking.
	15.....	Mar. 19, 1915	163	Milking.

TABLE XVII (*continued*)

Test No.	Date.	Germ content per liter of air.	BARN OPERATION IN PROGRESS AT TIME OF MAKING ANALYSIS.
1.....	July 28, 1914	59	Just before milking.
2.....	July 28, 1914	99	Milking.
3.....	July 28, 1914	100	Milking.
4.....	July 28, 1914	31	Milking.
5.....	July 28, 1914	116	Milking.
6.....	Jan. 26, 1915	54	Bedding cows.
7.....	Jan. 26, 1915	87	Milking.
8.....	Jan. 26, 1915	259	Milking.
9.....	Jan. 26, 1915	57	Milking.
10.....	Jan. 26, 1915	86	Milking.
Barn B 11.....	Jan. 26, 1915	746	Milking.
12.....	Jan. 26, 1915	761	Milking.
13.....	Jan. 26, 1915	239	Milking.
14.....	Mar. 17, 1915	50	Before milking.
15.....	Mar. 17, 1915	14	Before milking.
16.....	Mar. 17, 1915	241	Milking.
17.....	Mar. 17, 1915	371	Milking.
18.....	Mar. 17, 1915	530	Milking.
19.....	Mar. 17, 1915	386	Milking.
20.....	Mar. 17, 1915	116	Milking.
21.....	Mar. 17, 1915	260	Milking.
22.....	Mar. 17, 1915	841	Milking.
23.....	Mar. 17, 1915	427	Milking.
1.....	Mar. 18, 1915	193	Barn empty except for calves and chickens.
2.....	Mar. 18, 1915	127	Barn empty except for calves and chickens.
3.....	Mar. 18, 1915	459	Barn empty except for calves and chickens.
4.....	Mar. 18, 1915	834	Bedding stalls.
5.....	Mar. 18, 1915	3,957	Cows in stable. Removing corn stover. Grain fed.
6.....	Mar. 18, 1915	2,400	Milking, 15 minutes later.
7.....	Mar. 18, 1915	250	Milking.
8.....	Mar. 18, 1915	514	Milking.
9.....	Mar. 18, 1915	619	Milking.
Barn C 10.....	Mar. 18, 1915	796	Milking.
11.....	Mar. 22, 1915	37	Barn empty. Removing manure and corn stover.
12.....	Mar. 22, 1915	51	Barn empty. Removing manure and corn stover.
13.....	Mar. 18, 1915	13	Barn empty.
14.....	Mar. 22, 1915	70	Bedding with straw. Cows (9) coming in barn.
15.....	Mar. 22, 1915	149	Brushing off cows.
16.....	Mar. 22, 1915	266	Feeding grain to cows
17.....	Mar. 22, 1915	149	Milking.
18.....	Mar. 22, 1915	66	Milking.
19.....	Mar. 22, 1915	13	Milking.
20.....	Mar. 22, 1915	167	Milking.

Barn C. This stable is one of the most poorly constructed and poorly kept stables in the vicinity. It is located in the basement of the barn and is poorly lighted by small windows near the ceiling. All of the interior stable construction is of wood. That part of the floor under the cows is of concrete. The rest of the floor is dirt which has become pulverized into a dry dust. At the time the stable was visited, the walls back of the cows were spattered with dry manure and there was plenty of fresh manure about. Cobwebs were abundant as was also dust on the ledges. At one visit the cows were more or less covered with manure.

In spite of these unfavorable conditions, the results of the twenty analyses made in this stable (by R.) are not extraordinarily high. Except during and immediately after such dusty operations as removing dry corn stover from the barn and bedding down with straw, the counts obtained do not show excessive numbers of bacteria in the air. As in the case of Barn A, the very high numbers did not persist for more than a short time after the dust-producing barn operation ceased. The first ten analyses were made in front of the cows not more than two feet away from the greatest source of the dust while the last ten analyses were made just behind the cows at least fifteen feet from the greatest source of the dust. The highest counts obtained (3,957 and 2,400 per liter of air) represent conditions similar to those obtained by stirring up a dust in the loft of Station stable while the remainder of the counts (18 out of the 20 made) were as low as those made in the Station stable.

The most important conclusion which can be drawn from these three series of analyses is that the air of ordinary cow stables is partically as free from bacteria as is the air of the Station stable under normal conditions. Under special circumstances, none of which extend over long periods of time, the number of bacteria increases to a point where they become a measurable source of contamination to the milk produced in the stable.

CONCLUSIONS.

It has been shown in the preceding pages that the number of bacteria found in the air of the Station stable during such barn operations as milking, feeding hay, grain and the like usually varies between 50 and 200 per liter of air. Occasionally much lower results were secured and also a few much higher, the highest being 825 per liter.

When sterile water was "milked" in the Station stable from an apparatus especially designed for the purpose, the germ content of the liquid was found to average 12 per cubic centimeter with a maximum of 73 and a usual range of 5 to 15 per cubic centimeter.

In order to get a much higher germ content in the air than occurred in the air of the Station stable even under the worst of the normal conditions, a large number of tests were made in the stable loft. Here it was easily possible, by sweeping up debris from the floor, to secure dusty conditions which were as bad as the worst possible conditions obtainable in commercial dairies. When a heavy dust was raised at the beginning of each test, the germ content of the air was usually between 1,000 and 2,000 per liter, with an average of 2,068, a minimum of 329 and a maximum of 5,200 per liter. When the dust was maintained continuously throughout the test, the numbers obtained in the completely satisfactory determinations averaged 9,575 bacteria per liter of air, with a minimum of 960, a maximum of 28,200, and a usual range from 2,500 to 10,000 per liter.

Sterile water "milked" under these extremely dusty conditions gave an average germ content of 47.6 per cubic centimeter when the dust was raised but once, the highest number being 133, and the usual range between 30 and 100 per cubic centimeter. When the heavy dust was maintained continuously, the average germ content of the water "milked" was 604 per cubic centimeter, with a minumum of 69, a maximum of 1,430 and a usual range of 300 to 1,000 per cubic centimeter.

In three commercial stables in the vicinity of the Station, 58 analyses gave only seven results in which the germ content of the air was greater than the highest count (825 per liter) obtained in the Station stable and of these seven only four were decidedly higher than this figure. Milking under the worst of these conditions would, as shown by the work done where an artificial dust was raised, have added from 100 to 1,000 or more bacteria per cubic centimeter to the milk. On the other hand, under the conditions usually found in these stables the number of bacteria added to milk drawn would have been so few as to be undetectable by known methods of analyses.

If the results secured by Winslow and Browne,[37] who have found that the average number of bacteria per cubic foot (about 28 liters) of country air was 56, for city street air 72, for offices 94, for factories 113 and for schools 96, are compared with the results which have just been given for cow stables it will be seen that the latter are relatively greater. This is to be expected, as relatively dusty barn operations such as feeding hay, grain and the like must be carried out several times daily in every cow stable.

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[37] Winslow, C.-E. A. and Browne, W. W. The microbic content of indoor and outdoor air. *Monthly Weather Review*, 42:452–453, 1914.

Other possible sources of contamination, such as the interior of the udder, the cow's body, the milkers' hands and clothes, and the condition of the utensils, must be kept in mind in interpreting the importance of the air as a source of milk contamination. Accurate data showing the relative values of each of these sources of contamination is not yet at hand. Harding and Wilson[38] report that an average of 500 bacteria per cubic centimeter may be expected in all milk as drawn from the udder. More recently, Prucha, Harding and Weeter[39] report that they find that an average of 57,077 bacteria per cubic centimeter are added to milk by washed but unsterilized milk pails. Under normal barn conditions, the air contamination is even less than is that from the udder and both are small in comparison with that from unsterilized milk pails.

In addition to the data showing the amount of contamination from the air in freshly drawn milk, data has also been secured which shows the effect of exposing a pail of milk to the stable air. The data was secured partly by experiment and partly by calculation from the experimental data. Under the conditions obtaining in the Station stable, it was found that an average of 55 colonies developed from the bacteria which fell on a square centimeter area when dry chopped hay was fed, 71 per square centimeter when dry grain was being fed and 114 per square centimeter when milking was in progress. When the effect of leaving five liters (about five quarts) of milk standing in an open 12-inch pail in the open stable for one hour was calculated from this data, it was found that the numbers of bacteria which would be added would be 96, 124 and 199 per cubic centimeter under the above conditions. This increase is so small that it would not be detectable in ordinary milk by known methods of analysis.

Since the condition of the barn air in the commercial dairies was found to be similar to that of the Station stable under normal conditions, it is probable that no greater contaminations than those just noted occur normally in such dairies.

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[38] See footnote 1, fourth reference.

[39] Prucha, M. J., Harding, H. A., and Weeter, H. M. Utensils as a source of bacterial contamination of milk. A paper read at the Phila. Meeting of the Soc. Amer. Bact., Dec. 1914. *Science*, N.S., 42: 353, 1915.

A few analyses indicate however that conditions are bad enough at times to produce measurable contaminations in the milk even if this is exposed for a short time only.

In drawing up rules for the production of sanitary milk, much emphasis has been placed upon practices designed to control the amount of dust. This has been done because it has been felt that large numbers of bacteria were added to the milk in this way. The data here presented show for the first time how great this contamination is. In no case have preconceived ideas regarding the effect of certain factors on the production of clean milk so overruled the results of actual observation as in this case. Dairymen and sanitarians who have been interested in the production of clean milk have been as badly misled as have surgeons and physicians. This was but natural because of the way in which our knowledge of air bacteria has developed. Bacteria do occur in the air of cow stables in relatively larger numbers than they do in the air of many other places. Occasionally under exceptionally dusty conditions, the numbers of bacteria getting into the milk from the air may be approximately as high as the numbers derived from the udder, but the number so derived under ordinary conditions does not increase the germ content of the milk to any important extent.

THE PASTEURIZATION OF DAIRY BY-PRODUCTS.*

W. D. DOTTERRER AND ROBERT S. BREED.

In co-operation with the

NEW YORK STATE COMMISSION FOR THE INVESTIGATION OF BOVINE TUBERCULOSIS

THEOBALD SMITH, Chairman. LINSLY R. WILLIAMS, Secretary.

SUMMARY.

1. Visits were made in the course of this investigation to seven cheddar cheese factories and to two skimming stations at which pasteurization of whey or skim milk was being carried out. According to the 1915 list there are about 950 cheese factories in the State. Of these, 55 are known to be pasteurizing whey. Thirty-one of these factories make cheddar, 13 make swiss, 9 make limburg and 2 make brick cheese.

2. At but one of the cheese factories visited were the temperatures used in pasteurization high enough to meet the lowest requirement (178° F.) usually specified by law. At this factory the temperature used only occasionally reached this figure. All but two factories, however, were using temperatures which would meet the requirements of the Michigan law (145° F. for 30 minutes). The two factories which used lower temperatures than this were also losing part of the value of the pasteurization by adding separator slop or water after the temperature was so low as to be ineffective in killing bacteria. One other factory followed this same practice so that the pasteurization which would have otherwise been effective was rendered unsatisfactory. The four factories which were securing satisfactory results were all pasteurizing by means of a steam line running into the whey tank.

3. It was found that the process of heating the whey aided in preserving the whey in good condition for feeding until it was convenient to use it. This was due to the fact that the fat did not rise as quickly nor as completely on the heated as on the unheated whey, thus preventing the formation of an undesirable scum of fat on the whey tank. The heating also killed all of the organisms which ordinarily cause fermentations in the whey with the exception of *Bacillus bulgaricus* an organism which causes a lactic

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* A reprint of Bulletin No. 412, December, 1915.

acid fermentation. The growth of this organism was retarded by the heating so that the heated whey as delivered to the farmers had an acidity of about .4 per ct. while the unheated whey had an acidity of about 1.1 per ct.

4. The pasteurized whey was found to be free from yeasts and to undergo a practically pure lactic acid fermentation due to *B. bulgaricus.* On two successive days at one cheese factory, the same organism was also found to be the predominant organism in the making vat instead of the more common *Bacterium lactis acidi.*

5. The use of direct steam and the combination of direct steam and jetting were found to be the best methods of pasteurizing whey. These can be operated at a sufficiently low cost to make the process of pasteurization a highly desirable one for all parties concerned. Double jetting without supplementary heating is not satisfactory because the temperatures reached are not as high as they should be. This method has one advantage, however, in that a careless or unreliable cheese maker can not escape using the jet pumps while such a man may be tempted to shut off steam more quickly than he should where direct steam is used.

6. In the course of this investigation 40 butter factories and skimming stations were found which pasteurize skim milk. This number does not include all that follow the practice. The best procedure is to return the skim milk to the patrons' cans at a temperature high enough to remain above 145° F. for 30 minutes. This pasteurizes the milk in the final container and increases the keeping qualities of the skim milk.

INTRODUCTION.

In 1914, the New York State Commission for the Investigation of Bovine Tuberculosis recommended the passage of a law compelling the pasteurization of dairy by-products before their return to patrons of creameries and cheese factories for feeding purposes.[1] The law was not passed because of opposition which was largely due to lack of information concerning the effects and methods of pasteurization and its cost. For the purpose of securing information on these points, this investigation was undertaken by the Station at the request of the Commission.

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[1] Report of the Commission for the Investigation of Bovine Tuberculosis. Published by the State of New York, March, 1915.

STATEMENT OF THE PROBLEM.

According to the 1915 list[2] of butter and cheese factories in New York State, there are 716 cheese factories, 234 factories making both butter and cheese, 290 butter factories and 29 skimming stations in the State. Nearly all of the factories which make cheese return the whey to their patrons for feeding purposes. The skim milk is not so generally returned from the butter factories and skimming stations, as it is frequently used in making casein, milk powder and cottage cheese or utilized in other ways. The common use of whey and skim milk for feeding calves and pigs makes it very important to the farmer that they be returned to him from the factory in the most suitable condition for feeding and in such condition that they will not cause the spread of tuberculosis, foot-and-mouth disease or other like troubles through his herd.

In the course of the investigation, 55 cheese factories (31 cheddar, 13 swiss, 9 limburg, 2 brick) and 40 butter factories or skimming stations have been found which pasteurize the whey or skim milk returned to their patrons. Nearly all of this pasteurization has been started within the past few years. In every case where definite information was secured, both the factory owners and farmers were well pleased with the results and would not give up the practice. The introduction of the process of pasteurization at cheese factories has been coincident in many cases with the introduction of the making of whey butter. The adoption of either or both of these processes at a cheese factory is usually a good indication of progressiveness on the part of cheese maker or dairy farmers or both.

PLAN AND EXTENT OF THE WORK.

The available information on the subject of the pasteurization of dairy by-products has been collected in the course of the investigation and will be discussed later so far as it applies to New York State conditions. The field work undertaken was planned in order to study the effect of pasteurization on the whey and skim milk, the efficiency of the present methods of pasteurization, and the best methods of pasteurization.

During the course of the work samples were collected from seven cheese factories and two skimming stations, before, during and after pasteurization. These samples were iced and shipped to the laboratory at Geneva, reaching the laboratory in 10 to 20 hours, or were plated at the factory. The number of bacteria per cubic centimeter was determined as accurately as possible by the present methods of bacteriological analysis. The medium used in plating was the plain agar recommended by the Committee on Standard Methods for Bacterial Milk Analysis [3] and the plates were incubated for five days at 21° C. and counted. After this they were incubated for two additional days at 37° C. and recounted, a procedure which proved to have great value, as there were numerous organisms present which failed to appear on the plates at the end of five days. All samples were plated in several dilutions and no count is given which is not the average of at least two satisfactory plates, and few counts were averaged from as small a number of plates as this. All counts given in the tables are for one cubic centimeter of material. The larger part of the plating was done by Mr. G. L. A. Ruehle, to whom the thanks of the authors are due.

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[2] List of Butter and Cheese Factories, Milk Stations and Condensing Plants in New York State. Dept. Agri. N. Y. State, Bul. 69, pp. 1141–1205. 1915.

By means of these plate counts, the relative efficiency of the various methods of pasteurization was found. Records of the temperature used in pasteurization were also taken at the same time as the samples and a recording thermometer was installed for 5 days at one cheese factory using a double-jetting system of pasteurization and for 41 days at another using the method of direct steaming in the whey tank. These temperature records proved of value for they were easily secured and the record of the temperature used was sufficient to show the general efficiency of the pasteurization.

METHODS OF PASTEURIZING WHEY AND SKIM MILK IN USE.

In the ordinary cheese factory, the whey is run from the making vat to a tank where it remains until the next morning when it is taken away by the patrons. This gives an opportunity for the use of several methods of pasteurization. One method in use is to run a steam pipe directly into the whey tank through which steam is admitted, thus heating the whey to the required temperature. Several different arrangements of piping have been recommended for this purpose.[4]

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[3] Committee on Standard Methods for Bacterial Milk Analyses, Report. *Amer. Jour. Pub. Health,* 5:64. 1915.

[4] Herns, Frank and Publow, G. G. Notes on cheddar cheese-making. Ont. Dept. Agri., Dairy Branch, Bul. 183, pp. 19, 6 figs. 1910.

Farrington, E. H., and Hastings, E. G. The pasteurization and the inspection of creamery and cheese factory by-products. Wis. Agr. Exp. Sta., Bul. 148, pp. 17, 3 figs. 1907.

Some factories were found which subjected the whey to a preliminary heating by using a jet pump to deliver the whey to the storage tank where the whey was heated to a pasteurizing temperature by direct steam.

Much confusion has arisen in the statements made concerning the amount of water added to the whey or skim milk by this procedure because of the inaccurate statement made on page 6 of the Pennsylvania circular[5] giving data on the pasteurization of skimmed milk. At this place it is stated that the data obtained show that 7/10 of 1 per ct. of water is added to the skim milk. However, the data given in the same circular show that the statement intended was probably that *the percentage of water in the milk was increased* 7/10 *of 1 per ct.* which is quite a different matter. In order to increase the percentage of water in skim milk 7/10 of 1 per ct., that is, from approximately 90.4 to 91.1 per ct. water, it is necessary to add 8 lbs. of water to each 100 lbs. of milk.[*]

If this is the true explanation of the matter, then the Pennsylvania results are very similar to those found at Wisconsin[6] and the apparent wide discrepancy disappears. There is no real objection to the addition of this small quantity of water although it does reduce the percentage of solids in the whey or skim milk by the small amount indicated. The patrons are satisfied, as they demand quantity rather than quality in most cases.

A second method of pasteurization in use, especially at factories where the butter fat is removed from the whey with a separator is a double-jetting system. The whey is raised from the making vat to an elevated tank by means of a steam jet pump, a process which raises the temperature of the whey 16° to 29° F. (average 23.5°). The second jetting after the separation of the cream raises the temperature about 17° more. Since the initial temperature of the raw whey is usually between 98 and 102 (average 99), the final

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[5] Marshall, C. J., and Ridge, W. H. Pasteurisation of skimmed milk. Penn. State Livestock Sanitary Board, Cir. 31, pp. 9, 1914.

[*] Let x = number of lbs. of diluted milk
Then $.911x$ = number of lbs. water in diluted milk
But lbs. water in diluted milk $= 90.4 + (x - 100) = x - 9.6$
Hence $x - 9.6 = .911x$

$$x - .911x = 9.6$$
$$.089x = 9.6$$
$$x = \frac{9.6}{.089} = 107.8 +$$

or about 8 lbs. water added to each 100 lbs. milk.

[6] See footnote 4, second reference.

average temperature of the whey in the storage tank is about 139° F. This final temperature does not represent the highest temperature reached, for, during the passage through the second jet pump, the whey is heated to 150° or even 160° F., cooling down to the final temperature in its passage through the pipes into the storage tank. At one factory, the arrangement of equipment is such that when the jet pump fails, as it did on one occasion, the whey is run into the storage tank by gravity. In such cases the whey is not pasteurized unless some supplementary method of heating is at hand.

A third method of whey pasteurization was found at one factory where a Victor pasteurizer was in use. The condensed steam is added to the whey in this case as in the methods just described. The temperatures were easily regulated. A simpler device which is similar in principle is recommended by the Pennsylvania State Livestock and Sanitary Board.[7] Both of these are suitable for skim milk pasteurization as well as for whey pasteurization.

One skimming station visited was using a Reid flash pasteurizer and another a Wizard holding pasteurizer for heating skim milk. Other flash or holding pasteurizers are equally satisfactory if operated at a sufficiently high temperature. However, the use of these more expensive pasteurizers increases the cost of pasteurization with little if any increased efficiency. Exhaust steam can be used for heating where available in sufficient quantity.

EFFECTS OF PASTEURIZATION.

A. ON FEEDING VALUE

The effect of pasteurization on whey is more evident to the ordinary observer at factories where the whey is not skimmed. In case the whey is neither skimmed nor pasteurized, the fat in the whey rises forming a dirty, greasy scum on the surface of the storage tank. Where the whey is pumped out from the bottom of the tank, this greasy scum remains in the tank from day to day growing larger in quantity and worse in foulness. Occasionally some gets into patrons' cans, making them difficult to clean and usually resulting in contaminating the milk brought to the factory. In many cases, cleaning of the storage tank is neglected or never done. The final result is the loss of the greater part of the butter fat and the foulest kind of sour swill for feeding. In those cases where the whey is drained out of the vat by a faucet, the last patron to get his whey usually gets the bulk of the fat. This prevents the accumulation of the scum referred to above but the milk cans are fouled with the greasy mass which is richly seeded with undesirable bacteria and yeasts. Pasteurization of the whey retards the rising of the butter fat. Thus it remains equally distributed throughout and each patron receives his due share and in such form that it does not foul his milk cans.

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[7] Marshall, C. J. Pasteurizing device for use in a creamery. Penn. State Livestock Sanitary Board, Cir. 28, pp. 4, 1 fig. 1914.

It has been found[8] that 155° F. is the average temperature to which whey can be heated without coagulating the albumin. When the albumin is coagulated it may settle or it may rise to the top of the tank and require stirring to get it distributed evenly. However, it never tends to accumulate in the tank in the way in which the fat accumulates in tanks containing unpasteurized whey so that it is all returned to the farmers and is of value for feeding purposes. It makes but .7 per ct. of the whey and is less important as a food than is the milk sugar present.

The Ontario Department of Agriculture reports[9] as the result of a series of experiments that unskimmed whey is 25 to 33 per ct. better for feeding purposes than skimmed whey. Since improperly handled unpasteurized whey is practically skimmed whey, the patrons lose this value which would be saved to them if the whey were pasteurized.

The skimming of the whey eliminates these troubles and adds to the patrons' income by the sale of the whey butter or cream. The loss to the patron in the feeding value of the whey is little more than it is in those cases where the fat is allowed to waste by rising to the top of the tank. The practice of making whey butter is spreading and is to be commended.[10]

Where unheated whey is not fed at once after being drawn from the making vat, some of its feeding value is lost through the fermentations which take place in it. Previous investigations[11] as well as our own have shown that about one-fifth of the milk sugar is thus changed to acid where the whey is kept over night at the factory before being returned to the patrons. Alcoholic and other fermentations may also occur, all of which tend to decrease the food value of the whey. The effect of heating the whey is to stop practically all of these fermentations except the lactic-acid fermentation and this is greatly retarded. It has been found in the present investigation that the lactic-acid fermentation of both the heated and the unheated whey is due to *Bacillus bulgaricus*, an organism generally regarded as beneficial in its effect on digestive processes.

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[8] Page 15. Herns, Frank. The pasteurization of cheese factory whey. Rept. 3rd Dominion Conference Dairy Experts, pp. 13-18. 1911. Published by Dept. Agr. Canada, Ottawa.

[9] Day, G. E. Comparison of various dairy by-products as foods for swine. 34th Ann. Rept. Ont. Agr. Col. and Exp. Farm, pp. 147-148. 1909. Idem., 35th Ann. Rept., pp. 141-145. 1910.

[10] Farrington, E. H. The manufacture of whey butter at swiss cheese factories. Wis. Agr. Exp. Sta., Bul. 132, pp. 32, 17 figs. 1905.

Doane, C. F. Whey butter. U. S. Dept. Agr., Bur. An. Ind., Cir. 161, pp. 7. 1910.

Sammis, J. L. Making whey butter at cheddar cheese factories. Wis. Agr. Exp. Sta., Bul. 246, pp. 24, 5 figs. 1915.

[11] Page 7 in first reference given in footnote 4.

Very few studies have been made to show the best method of handling pasteurized skim milk. The practice of cooling the skim milk and returning it in that condition may be very unsatisfactory as has already been pointed out[12] because of the fact that the skim milk is commonly put into unsterilized cans which seed the milk heavily with bacteria and so cause it to sour quickly. The best results are obtained when the milk is run into the farmers' cans at a temperature high enough so that the milk remains hotter than 145° F. for 30 minutes. In this way most of the bacteria which have entered the milk after the original heating, from contaminated pipes, pumps, cans and the like, are killed. If such milk is cooled by the farmer on his return to the farm, it should remain sweet longer than 24 hours.

If the milk is delivered warm to the farmers but at a temperature lower than that mentioned above, the conditions then become very favorable for the growth of the bacteria with which the milk has been infected and it may sour within a few hours.

Feeding experiments with pasteurized skim milk have been carried out at the Ontario and Kansas[13] stations. In general these show little change in feeding value by the pasteurization, but such advantage as there is, is in favor of the pasteurized skim milk.

B. ON THE SPREAD OF DISEASE.

There are many records which show without question that bovine tuberculosis may be and is spread by the indiscriminate feeding of unpasteurized dairy by-products. Thus the Wisconsin Station has published[14] an account of a very striking instance of the sort. In the course of the work of testing cattle, they found that a very large percentage of the animals in the region of two creameries reacted to the tuberculin test. A comparison was therefore made with the surrounding districts with the following result: In the Medina and Oak Park districts, 1213 cattle were tested of which 374 or about 30 per ct. reacted. Of the reacting animals 323 were killed under federal inspection and 184 or 57 per ct. were condemned, while of 73 animals killed and inspected from the surrounding districts, 25 or about 33 per ct. were condemned. Thus there was not only evidence that some agent was operative in spreading the disease in the Medina-Oak Park District which was not operative in the other districts but there was also evidence of a more severe infection in this district. A few of the tubercular animals may have been brought into the district by purchase, but the majority of the infected animals were known to have been raised on the farms. Only an infected skim-milk supply could account for such conditions.

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[12] Page 9 in second reference given in footnote 4. Also Farrington, E. H. Pasteurization of skim milk. Wis. Agr. Exp. Sta., 16th Ann. Rept., pp. 121–128. 1899.

[13] Cottrell, H. M., Otis, D. H., and Hanly, J. G. Skim milk calves. Kan. Agr. Exp. Sta., Bul. 97, pp. 15. 1900.

Dean, H. H. Pasteurized vs. raw skim milk for calves. 25th Ann. Rept. Ont. Agr. Col. and Exp. Farm, pp. 67. 1900.

Ostertag reports[15] that in advanced udder tuberculosis, the secretions from the infected quarters may be virulent in a dilution of one to one billion. Cows with infected quarters are occasionally present in every dairy district and the admixture of their milk with good milk at a cheese factory infects the whole. Two recent publications[16] report the presence of virulent tubercle bacilli in fresh unpasteurized whey.

Within the past two years, a very strong argument for the compulsory pasteurization of all dairy by-products has been presented by the spread of foot-and-mouth disease throughout many dairy sections. In some instances[17] the conditions surrounding outbreaks have indicated very clearly that the return of unpasteurized skim milk has spread this infection.

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[14] Russell, H. L. The spread of tuberculosis through factory skim milk with suggestions as to its control. Wis. Agr. Exp. Sta., Bul. 143, pp. 28. 1907.

[15] Page 8. Ostertag, Robert von. Die Bekämpfung der Tuberculose des Rindes. XII + 591 pp., 88 figs. Berlin: 1913.

[16] Barthel, Chr. and Stenström, O. Untersuchungen über die Widerstandkraft der Tuberclebasillen gegen Erhitsung in Molken. *Ztschr. Fleisch-u. Milchhyg.*, 22:137-142, 179-187. 1912.

Burri, R. and Geilinger, Hans. Die Gefahr der Ausbreitung der Tuberculose unten den Schweinen infolge der Verfütterung nicht erhitster Zentrifugenmolke *Milchw. Zentbl.*, 44: 305-309, 1915.

[17] Raw skimmed milk. *Weekly News Letter*, U. S. Dept. Agr., 2:6. May 19, 1915.

For these reasons pasteurization is being advocated in many places and several states have passed laws compelling the pasteurization of skim milk, whey and similar products. The Pennsylvania law requires the heating of dairy by-products to a temperature of at least 178° F., Iowa requires 185° F., Minnesota requires 180° F., while Michigan requires 185° F. or 145° F. for 30 minutes.

The temperature to which milk or whey must be heated to kill tubercle bacilli has been the subject of much investigation. The available data have been summarized by Rosenau[18] who verifies by his own work the conclusion that a temperature of 140° F. for 20 minutes will prevent tubercle bacilli from producing the disease in inoculated animals. Russell and Hastings[19] find that under ideal conditions 160° F. for one minute will kill the tubercle germ, but that 170° F. for the same length of time is more certain to do so under ordinary conditions.

Other considerations than those just mentioned have caused the requirement of the higher temperatures in the laws quoted above. A law with no means of enforcement is of little benefit, as some men will evade a law if possible. Therefore these laws, with the exception of the Michigan law, have required the use of a temperature of at least 178° F., this temperature causing changes in the milk which are detectable by means of the Storch test.[20] Such a temperature kills the tubercle bacillus and other disease-causing organisms with a sufficient margin of safety where flash pasteurization is used and provides a very wide margin of safety where the holding process is used.

COST OF PASTEURIZATION.

It is essential that the cost of pasteurizing dairy by-products be held at a much lower figure than that allowable for market milk because the final value of the product is much less. Available figures[21] indicate that the cost of whey pasteurization does not exceed one cent per hundred pounds of whey. One manufacturer, who operates thirteen cheese factories, charges his patrons five cents per 100 pounds of cheese. This is approximately one-half cent per 100 pounds of whey. He states that he does not consider that this pays the whole cost but he is satisfied because of the decreased trouble with quality of the cheese produced. Another manufacturer, operating seventeen factories, charges one cent per 100 pounds of whey.

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[18] Rosenau, M. J. The thermal death points of pathogenic micro-organisms in milk. Pub. Health and Mar. Hosp. Ser. of U. S. Hygienic Lab., Bul. 42, 85 pp., 1 fig. 1908.

[19] Russell, H. L., and Hastings, E. G. Effect of short periods of exposure to heat on tubercle bacilli in milk. Wis. Agr. Exp. Sta., 21 Ann. Rept., pp. 178–192. 1904.

[20] Pages 12–17 in second reference given in footnote 4.

[21] Pages 17–19 in first reference given in footnote 4. Page 25 in reference given in footnote 1.

No reports of investigations were found which showed the cost of pasteurizing skim milk. This cost need not exceed that of whey pasteurization except in those instances where pasteurization must be carried on at the time when the maximum amount of steam is required for other purposes. This may mean that increased boiler capacity is needed and this raises the cost of pasteurization. Several of the factories which pasteurize skim milk are using a method of holding pasteurization comparable to the methods of pasteurization used in this State for market milk. The cost of such pasteurization is usually placed at from six to ten cents per hundred pounds. Such a high cost of pasteurization for dairy by-products is unnecessary and unprofitable for all concerned.

EFFICIENCY OF PASTEURIZATION AS CARRIED OUT IN NEW YORK STATE FACTORIES.

The results of the analyses of samples are given in the following tables. Three of the cheese factories visited used the method of direct steaming in the whey tank, two used a double-jetting system, one used a single jet for preliminary heating, following this by direct steaming in the whey tank, and one used a Victor pasteurizer. One of the skimming stations visited was using a Reid flash pasteurizer, running the hot skim milk directly into a tank from which the farmers drew it into their cans while still hot; the other was using a Wizard holding pasteurizer and cooled the skim milk before returning it. Thus many varied conditions were studied. Two of the main cheese districts were visited, one the Chautauqua-Cattaraugus district and the other the Jefferson County district.

For various reasons, it has been considered the wisest plan not to give the names and locations of the factories. Mention should be made at this place, however, of the unfailing courtesy shown and help given by the owners and operators of all the factories visited. We are indebted for particular courtesies or suggestions or both to the following: Geo. A. Smith, H. E. Cook, W. A. Stocking, H. S.

Sweetland, J. L. Gibby, D. M. Evans, R. R. Kirkland, Dana H. Wells, Wm. H. Sheffield, C. E. Sackett, W. D. Strack and F. X. Baumert Co.

A. WHEY PASTEURIZATION.

Table I gives the results of the bacterial analyses of the samples of whey taken at Factory A. Samples were taken at this factory on three days (August 17, 31 and September 1), all of which happened to be moderately warm summer days. At this place, the whey was siphoned out of the making vats directly onto the floor and ran in a trench in the concrete floor to a buried pipe which led to a half-buried plank whey-tank outside. The tank was seldom cleaned and the inside was covered with a thick scale. The whey was pasteurized in the tank by means of live steam which entered it through a pipe with a single opening. In spite of this, the whey was well circulated during the time when the steam was entering and there was rarely more than two degrees difference in temperature in different portions of the tank.

It was the intention of the cheese maker to heat the whey to at least 160° F. before shutting off steam. The temperature records taken on these three days as well as those taken by means of a recording thermometer and given in Table II show that he usually heated to a hotter temperature than this and occasionally reached a temperature as high as 178° F. As was to be expected, the bacteriological analyses show that he was getting very efficient pasteurization.

The whey itself was in good condition and had a clean, sweet smell, very different from that found where the whey is not pasteurized. The fat did not form a scum on the surface even after the whey stood over night. The albumin in the whey was curdled and tended to settle to the bottom but was easily stirred up by the farmers when they dipped out the whey so that it did not accumulate in the tank. The bacteriological examination showed this whey to have an abundant growth of a nearly pure culture of *B. bulgaricus* when it was delivered to the farmers (see page 231). As indicated in Table I this organism did not show up on the culture plates after five days of incubation at 21° C. but appeared in large numbers after incubation at body temperature (37° C.).

By means of a recording thermometer, a record of the temperatures used in pasteurization at this factory was kept from October 6 to November 15, a period of 41 days. These records have been

TABLE I.—EFFICIENCY OF WHEY PASTEURIZATION AT FACTORY A, BY DIRECT STEAMING IN WHEY TANK.

Sample No.	Time taken.	Material.	Temperature.	Plate count.	Notes.
		August 17, 1915.	*Degs. F.*		
1	8:30	Raw milk	.....	37,300,000	
2	7:00	Past. whey. Stood all night in tank	109	*41,600,000	*B. bulgaricus* predominant.
3	1:00	Raw whey from making vat	98	156,000,000	
4	1:15	Whey. Steamed in tank 15 minutes	136	41,470,000	
5	1:30	Steamed in tank 30 minutes	147	655,000	
6	2:00	Stood 30 minutes without steam	145	94,700	
7	2:30	Steamed 30 minutes	181	1,790	
8	3:00	Steam off 30 minutes	176	40	
9	3:30	Steam off 60 minutes	168	138	
10	4:00	Steam off 90 minutes	158	143	
11	4:30	Steam off 120 minutes	158	51	
		August 31, 1915.			
12	8:30	Raw milk	.....	2,450,000	
13	7:30	Past. whey. Stood all night in tank	102	*1,640,000	*B. bulgaricus* predominant.
14	11:30	Raw whey from making vat	98	18,500,000	
15	1:15	Raw whey from tank	.....	63,000,000	
16	1:30	Whey after 15 minutes steam	140	21,000,000	
17	1:50	Stood 20 minutes without steam	140	1,800,000	
18	2:05	15 minutes additional steam	168	11,300	
19	2:20	Steam off 15 minutes	165	10,500	
20	2:35	Steam off 30 minutes	163	9,650	
21	3:05	Steam off 60 minutes	158	900	
22	3:35	Steam off 90 minutes	154	700	
23	4:05	Steam off 120 minutes	158	†240	
		September 1, 1915.			
24	8:30	Raw milk	.....	1,500,000	
25	7:45	Past. whey. Stood all night in tank	98	*114,800,000	*B. bulgaricus* predominant.
26	1:00	Raw whey from making vat	100	37,600,000	
27	1:45	Raw whey from tank	.....	70,500,000	
28	2:00	Whey after 15 minutes steaming	135	22,000,000	
29	2:15	Whey after 30 minutes steaming	145	3,500,000	
30	2:45	Whey after 40 minutes steaming	171	25,000	
31	3:00	Steam off 15 minutes	169	26,000	
32	3:15	Steam off 30 minutes	165	17,000	
33	3:30	Steam off 45 minutes	161	6,000	
34	4:00	Steam off 75 minutes	156	6,000	

* The two days of extra incubation at 37° C. increased these counts from 2,900, 10,000 and 47,000 respectively to the figures given because the predominant organism did not appear until after incubation at the warmer temperature.

tabulated in Table II where it will be seen that the lowest temperature recorded was 158. On this day, the whey was hotter than 150° F. for ½ hour and hotter than 140° F. for 1½ hours. Even this minimum must have given very satisfactory pasteurization. The colder fall weather caused a decided difference in the form of the temperature curve, as the whey cooled more rapidly in the tank. A few sharp drops in the curve occurred which were undoubtedly due to adding cold water in order to make up for deficiencies in the amount of whey.

TABLE II.—TEMPERATURES USED IN PASTEURIZATION AT FACTORY A.
(Readings from a recording thermometer.)

DATE.		Maximum temperature.	Time above 160° F.	Time above 150° F.	Time above 140° F.	Time above 130° F.
		Degs. F.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Oct.	6	168	⅓	1⅓	2¼	4¼
	7	178	¾	1⅓	2⅓	4
	8	176	1	1¾	3¼	4¼
	9	168	¾	1⅓	2⅓	4
	10	165	⅓	1¼	2⅓	4
	11	171	⅓	1⅓	2⅓	4⅓
	12	171	¾	1¾	3	4⅔
	13	167	⅓	1¼	2	3⅓
	14	173	1¼	2¼	4	7
	15	172	1¼	2⅓	4⅓	6
	16	172	1	1¾	3	5
	17	171	¼	2⅓	3⅓	5¼
	18	174	1¼	1¾	3	4⅓
	19	164	¼	1	2	4
	20	168	⅔	1	2	3¾
	21	178	¾	1⅓	2¼	4¼
	22	175	1	1⅓	2⅓	3½
	23	167	¾	1⅓	2⅓	4
	24	158	0	⅔	1⅓	2¼
	25	167	⅓	1¼	2⅓	4
	26	170	⅓	1¼	2¼	3⅓
	27	168	⅓	1⅔	2¾	4
	28	167	⅓	1¾	3	4⅔
	29	170	¾	2	3	5¼
	30	172	1	1¾	2¾	4
	31	172	1	1¾	2¾	4
Nov.	1	165	¼	1	1¾	2¾
	2	179	⅓	1¼	2⅓	3¾
	3	174	¼	1	2	2¾
	4	167	⅓	1	1¾	2¾
	5	167	⅓	1¼	2¼	3¼
	6	174	¾	1⅓	2⅓	3⅓
	7	167	⅔	1¼	2	3¼
	8	168	⅓	1¼	2	3
	9	175	¾	1⅓	2¼	3½
	10	174	1¼	2¼	3⅓	5
	11	165	¼	1	2	3¼
	12	164	¼	1¼	2	3¾
	13	176	¾	1⅓	2	3
	14	165	¼	¾	1⅓	2¼
	15	176	¾	1⅓	2⅓	3½

Table III gives a record of the analyses of samples from Factory B taken on four different days (August 18, 19, September 2, 3). At this factory, the whey was jetted from the vat to a tank on the second floor. From this tank it ran by gravity through the separator into a barrel from which it was jetted to a wooden tub tank outside. The tank in this case was elevated a foot from the ground and was not covered. Under these conditions, the temperature of the whey was lowered a number of degrees on running into the tank and fell rapidly if the weather was at all cool. It was the practice at this factory to add the separator slop and washings to the whey about an hour after the whey had been run into the tank during which time it had usually cooled to 145° F. or less. Water was also added to the whey nearly every day in order to make it meet patrons' demands, thus cooling the whey still more. The whey tank was cleaned and was kept in excellent condition. The whey smelled clean and sweet and there was no accumulation of coagulated albumin. The bacteriological analyses showed that here, also, the predominant organism in the whey as it was delivered to the farmers was *B. bulgaricus*. Very few other bacteria were present.

The recording thermometer was used at this factory for five days when it was removed because the temperatures were not high enough to secure efficient pasteurization, due to the causes mentioned above. The records for these five days (September 2–6) showed maximum temperatures of 144, 149, 138, 135 and 142° F. respectively. On September 2, the temperature remained above 140 for 1½ hours. On September 3, it remained above 140 for 3 hours. On September 6, it remained above 140 for ½ hour. While the pasteurization at this factory could not be considered efficient as a means of killing the tubercle bacillus, yet it should be stated that an excellent feeding material was returned to the patrons and one which was much better than that received before pasteurization was introduced.

The records of the analyses of the samples taken at Factory C are given in Table IV. Samples were taken on August 20, 21 and 23 during moderately warm summer weather. This was the largest factory visited and about 17,000 lbs. of milk were being handled daily. The whey was jetted twice and separated as at Factory C. After the second jetting, the whey ran through about 50 feet of pipe inside the factory and then through about 40 feet of pipe buried beneath a driveway thus reaching a buried tub tank which was covered by a shed. In the morning the whey was jetted to a smaller elevated tank from which the patrons secured their whey by gravity. The whey had a good appearance when taken away and had none of the odor of sour swill.

TABLE III.—EFFICIENCY OF WHEY PASTEURIZATION AT FACTORY B, BY JETTING TWICE.

Sample No.	Time taken.	Material.	Temperature.	Plate count.	Notes.
		August 18, 1915.	*Degs. F.*		
35	10:45	Raw whey	102	23,100,000	
36	11:00	Whey jetted once	131	9,800,000	
37	11:15	Same. Stood 15 minutes	127	6,500,000	
38	12:00	Whey separated and jetted 2nd time.	151	29,300,000	
39	12:15	Same. Stood 15 minutes	151	†20,200	
40	12:30	Same. Stood 30 minutes	150	20,400	
41	1:00	Same. Stood 60 minutes	147	†12,300	
42	1:30	Same. Stood 90 minutes	145	†69,000	Separator slop added.
43	2:00	Same. Stood 120 minutes	143	†96,000	
		August 19, 1915.			
44	8:40	Raw milk	.....	11,500,000	
45	7:30	Pasteurized whey. Stood all night in tank	88	*68,500,000	*B. bulgaricus* predominant.
46	10:00	Raw whey in vat	102	†2,700,000	
47	10:10	Whey jetted once	129	3,400,000	
48	10:40	Same. Stood 30 minutes	126	1,600,000	
49	11:30	Whey separated and jetted 2nd time	153	301,000	
50	11:45	Same. Stood 15 minutes	151	12,700	
51	12:00	Same. Stood 30 minutes	151	11,600	
52	12:30	Same. Stood 60 minutes	147	†9,400	
53	1:00	Same. Stood 90 minutes	143	†191,000	Separator slop added.
54	1:30	Same. Stood 120 minutes	142	90,000	
55	2:00	Same. Stood 150 minutes	142	†67,000	
		September 2, 1915.			
56	7:30	Raw milk	.....	4,800,000	
57	7:00	Pasteurized whey. Stood all night in tank	86	*4,134,000	*B. bulgaricus* predominant.
58	10:30	Raw whey in vat	100	13,300,000	
59	11:00	Whey jetted once	127	9,600,000	
60	11:30	Same. Stood 30 minutes	124	1,730,000	
61	12:00	Same. Stood 60 minutes	.....	2,080,000	Rise in count due to standing at warm temperature.
62	11:45	Whey separated and jetted 2nd time.	142	1,180,000	
63	12:05	Same. Finished separating	142	150,000	
64	12:35	Same. Stood 30 minutes	141.5	124,000	
65	1:05	Same. Stood 60 minutes	140	50,000	
66	1:35	Same. Stood 90 minutes	139	455,000	Separator slop added.
67	2:05	Same. Stood 120 minutes	135	416,000	
		September 3, 1915.			
68	7:00	Raw milk	.....	350,000	
69	6:45	Pasteurized whey. Stood all night.	90	*81,720,000	*B. bulgaricus* predominant.
70	10:00	Raw whey	100	12,700,000	
71	10:10	Whey jetted once	127	8,000,000	
72	10:40	Same. Stood 30 minutes	123	2,400,000	
73	11:15	Whey, separated and jetted 2nd time	149	508,000	
74	11:30	Same. Stood 15 minutes	148	165,000	
75	11:45	Same. Stood 30 minutes	148	99,000	
76	12:15	Same. Stood 60 minutes	145	159,000	Separator slop added.
77	12:45	Same. Stood 90 minutes	144	148,000	
78	1:15	Same. Stood 120 minutes	142	136,000	
79	1:45	Same. Stood 150 minutes	141	116,000	

† Five day count at 21° C. The seven day count was lost because of spreaders or for other reasons.

* The two days of extra incubation at 37° C. increased these counts from 10,000, 4,150 and 3,000 respectively to the figures given because the predominant organism did not appear until after incubation at the warmer temperature.

The fact that the whey ran such a distance after the second jetting caused considerable cooling so that the temperatures given for the whey in the tank are about 20 degrees lower than those at the jet. In colder weather this reduction would have been greater. As it was, the pasteurization would have been fairly efficient, as shown by the results obtained August 21, if it had not been a practice to add separator slop after the whey had cooled below a pasteurizing temperature. On August 23, the second jet pump failed when only part of the whey had been pumped and the remainder was heated to 160° F. by direct steam in the barrel which received the discharge from the separator and was then allowed to run into the tank by gravity through a trench in the floor. This of course gave unsatisfactory results from the bacteriological standpoint. The high counts on August 21, which persisted until after the whey had been heated 60 minutes, were undoubtedly caused by the fact that some of the whey from the preceding day had remained in the tank. This and the preceding factory were improving the feeding value of the whey very markedly by the pasteurization but were not getting results which could be regarded as satisfactory as a means of preventing the spread of tuberculosis or foot and mouth disease.

Samples were taken at Factory D on August 24, 25 and 26 and the results of the analyses are given in Table V. The whey is separated at this factory after it has been jetted out of the making vat. As it left the separator it ran by gravity through a Victor pasteurizer placed near the separator and below the discharge. This type of pasteurizer consists of a horizontal metal cylinder about 18 inches long and 6 inches in diameter. The whey enters one end and is mixed with live steam admitted at the top of the cylinder. It leaves the pasteurizer at the opposite end and flows by gravity to the whey tank. The tank at this factory was much like that at Factory A except that it was raised about two feet above the surface of the ground. Temperatures were easily regulated by means of this pasteurizer and satisfactory results would have been secured if separator slop had not been added after the whey had cooled somewhat.

B. bulgaricus was found to be the predominant organism in the whey as returned to the farmers. Microscopic smears were made of the old whey on August 25 and 26 according to the method described in Bulletin 373 [22] of this Station except that the whey was diluted with equal quantities of sterile skim milk before preparing the dried smear. Counts made from these smears showed *B. bulgaricus* to be present in the enormous numbers of 101,000,000 on

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[22] Brew, James D. A comparison of the microscopical method and the plate method of counting bacteria in milk. N. Y. Agr. Exp. Sta., Bul. 373, 38 pp., 2 pl. 1914.

TABLE IV.— EFFICIENCY OF WHEY PASTEURIZATION AT FACTORY C, BY JETTING TWICE.

Sample No.	Time taken.	Material.	Temperature.	Plate count.	Notes.
		August 20, 1915.	*Degs. F.*		
80	9:30	Raw milk mixed from three vats....	.....	16,800,000	
81	10:00	Raw whey..........................	100	7,900,000	
82	11:00	Whey jetted once..................	120	†7,460,000	
83	12:30	Whey separated and jetted 2nd time.	140	99,000	Temperature at jet 160° F.
84	12:45	Same. Stood 15 minutes..........	140	†15,200	
85	1:00	Same. Stood 30 minutes..........	138	25,000	Cooled in passing through 90 feet of piping.
86	1:30	Same. Stood 60 minutes..........	136	53,000	
87	2:00	Same. Stood 90 minutes..........	134	121,000	
88	2:30	Same. Stood 120 minutes.........	134	96,000	Separator slop added.
89	3:00	Same. Stood 150 minutes.........	131	110,000	
90	4:00	Same. Stood 210 minutes.........	127	†144,000	
		August 21, 1915.			
91	9:00	Raw milk..........................	.....	23,000,000	
92	9:30	Raw whey..........................	100	7,500,000	Persistent high counts undoubtedly due to old whey left in tank from preceding day.
93	10:40	Whey jetted once..................	116	†4,300,000	
94	11:20	Whey. First jetting finished......	120	†5,800,000	
95	12:45	Whey separated and jetted 2nd time.	142	1,070,000	
96	1:00	Same. Stood 15 minutes..........	142	2,040,000	
97	1:15	Same. Stood 30 minutes..........	141	1,750,000	
98	1:45	Same. Stood 60 minutes..........	140	91,000	
99	2:15	Same. Stood 90 minutes..........	138	†13,000	No separator slop added.
100	2:45	Same. Stood 120 minutes.........	136	15,000	
101	3:15	Same. Stood 150 minutes.........	134	†8,760	
102	4:15	Same. Stood 210 minutes.........	133	12,080	
		August 23, 1915.			
103	9:00	Raw milk..........................	.....	20,000,000	
104	8:45	Pasteurized whey. Stood over night in tank..........................	110	53,000	*B. bulgaricus* probably present in large numbers but failed to develop.
105	10:00	Raw whey..........................	100	15,000,000	
106	11:00	Whey jetted once..................	118	10,000,000	Jet failed when two-thirds done and remainder of whey ran into tank by means of open trench in floor after heating to 160° F. in barrel at separator.
107	12:45	Whey separated and jetted 2nd time.	131	720,000	
108	1:00	Same. Stood 15 minutes..........	130	1,000,000	
109	1:45	Same. Stood 45 minutes..........	127	490,000	
110	2:15	Same. Stood 75 minutes..........	125	359,000	
111	2:45	Same. Stood 105 minutes.........	124	137,000	
112	3:15	Same. Stood 135 minutes.........	122	810,000	Separator slop added.
113	4:15	Same. Stood 195 minutes.........	116	170,000	

† Five day count at 21° C. Seven day count lost because of spreaders or for other reasons.

August 25, and 331,000,000 on August 26. In spite of this no *B. bulgaricus* colonies appeared on the plates made on August 25 and not more than one-third of the number present appeared on the plates made August 26.

Samples were taken on August 27 and 30 from Factory E and the results of the analyses are given in Table VI. The whey was not

TABLE V.— EFFICIENCY OF WHEY PASTEURIZATION AT FACTORY D, BY JETTING ONCE AND RUNNING THROUGH A VICTOR PASTEURIZER.

Sample No.	Time taken.	Material.	Temperature.	Plate count.	Notes.
		August 24, 1915.	*Degs. F.*		
114	8:30	Pasteurised whey. Stood all night.	104	*9,860,000	*B. bulgaricus* predominant.
115	10:30	Raw whey	100	18,000,000	
116	10:45	Whey jetted once	126	14,000,000	
117	11:00	Same. Stood 15 minutes	126	11,000,000	
118	12:50	Whey in storage tank. Separated and pasteurized	149	335,000	
119	1:20	Same. Stood 30 minutes	153	144,000	
120	2:00	Same 40 minutes later. Finished pasteurising	153	119,000	
121	2:15	Same. Stood 15 minutes	151	105,000	
122	2:30	Same. Stood 30 minutes	149	67,000	
123	3:00	Same. Stood 60 minutes	145	6,200	
124	3:30	Same. Stood 90 minutes	145	138,000	Separator slop added.
125	4:00	Same. Stood 120 minutes	143	1,000	
		August 25, 1915.			
126	8:30	Raw milk	.....	2,270,000	
127	7:30	Pasteurised whey. Stood all night.	113	856,000	Plates did not show *B. bulgaricus* colonies. Microscope showed them to be present. Count — 101,000,000.
128	11:00	Raw whey	100	†4,500,000	
129	11:50	Whey jetted once. Stood 15 minutes.	126	†3,500,000	
130	1:20	Whey. Jetting 2nd vat	124	5,120,000	
131	2:00	Whey from discharge of pasteuriser.	154	165,000	
132	2:30	Whey in storage tank	142	310,000	
133	3:30	Same. Finished pasteurising	142	117,000	
134	3:45	Same. Stood 15 minutes	142	13,000	
135	4:00	Same. Stood 30 minutes	140	80,000	Separator slop added.
136	4:15	Same. Stood 45 minutes	138	32,000	
137	4:30	Same. Stood 60 minutes	138	120,000	
		August 26, 1915.			
138	8:30	Raw milk	.....	2,400,000	
139	7:15	Pasteurised whey. Stood all night.	118	*77,600,000	*B. bulgaricus* predominant. Microscopic count — 331,000,000.
140	11:20	Raw whey	100	3,300,000	
141	12:00	Whey jetted once	124	2,500,000	
142	1:05	Whey from discharge of pasteurizer.	161	3,700	
143	3:00	In tank. Finished pasteurizing	151	61,000	Some raw whey added
144	3:30	Same. Stood 30 minutes	149	21,000	
145	4:00	Same. Stood 60 minutes	149	†8,500	
146	4:30	Same. Stood 90 minutes	148	11,500	

* Two days of extra incubation at 37° C. increased these counts from 151,000 and 7,400 respectively to the figures given because the predominant organism did not appear until after incubation at the warmer temperature.

† Five day count at 21° C. Seven day count lost because of spreaders or for other reasons.

separated at this factory but was drawn from the vat by a single jet pump and ran by gravity in a wooden trough to the whey tank where the pasteurization was finished by direct steam. A half-inch steam pipe was used which ran about 40 feet before entering the tank, about half of the distance being outside of the building. On account of the heat lost by radiation the pasteurization occupied a longer time than would have been required if other arrangements had been made. The whey tank was a wooden tub placed on the surface of the ground, from which the whey was dipped by the farmers. It will be seen by the table that the old whey on August 27 had not been pasturized on the previous day. The plate count was 3,380,000 with no *B. bulgaricus* colonies. The microscopic count was 404,000,000 with *B. bulgaricus* predominant.

TABLE VI.—EFFICIENCY OF WHEY PASTEURIZATION AT FACTORY E, BY SINGLE JETTING FOLLOWED BY DIRECT STEAMING IN WHEY TANK.

Sample No.	Time taken.	Material.	Temperature.	Plate count.	Notes.
		August 27, 1915.	*Degs. F.*		
147	8:30	Raw milk	.....	6,700,000	
148	8:00	Whey stood over night, not pasteurized	90	3,380,000	Microscopic count—404,000,000. Largely *B. bulgaricus* with no yeasts.
149	1:00	Raw whey	98	53,000,000	
150	1:40	Whey jetted once	118	52,000,000	
151	2:00	Same. Steamed in tank 15 minutes.	120	57,000,000	Cold whey added from curd sink.
152	2:15	Same. Steamed 30 minutes	127	44,500,000	Steam pressure low and steam was on 2¼ hours.
153	2:45	Same. Steamed 60 minutes	136	†9,820,000	
154	3:15	Same. Steamed 90 minutes	147	159,000	
155	3:30	Same. Steamed 105 minutes	153	33,000	
156	3:45	Same. Steamed 120 minutes	156	15,100	
157	4:00	Steamed 135 minutes. Steam shut off	158	7,400	
158	4:15	Steam off 15 minutes	158	1,600	
		August 30, 1915.			
159	8:00	Pasteurised whey stood over night.	119	630,000	*B. bulgaricus* did not develop but probably present.
160	11:00	Raw whey	98	22,300,000	
161	12:15	Whey jetted once	120	53,300,000	
162	1:00	Same. Steamed 30 minutes	147	286,000	
163	1:30	Same. Steamed 60 minutes	156	20,000	
164	2:00	Steamed 90 minutes. Steam shut off	167	1,060	
165	2:15	Same. Stood 15 minutes	167	2,800	
166	2:30	Same. Stood 30 minutes	165	2,700	
167	3:00	Same. Stood 60 minutes	164	1,700	
168	3:30	Same. Stood 90 minutes	162	2,600	
169	4:00	Same. Stood 120 minutes	160	3,500	

† Five day count at 21° F. Seven day count lost because of spreaders or for other reasons.

On the first day, the whey was heated to 158° F. and to 167° F. on the second day. On both days there was an excellent percentage reduction in numbers of bacteria and there can be little doubt but that all disease-causing organisms were killed.

Conditions at Factory F were much the same as at Factory A. Samples were taken on September 27 and 28 (Table VII), which happened to be cool days. The whey was siphoned out of the vat and ran by gravity to the tank where direct steam was used to pasteurize it. The tank, which is placed on the surface of the ground, is made of planks and is covered by a rough shed. The cheesemaker at this factory makes it a practice to shut off steam as soon as the temperature reaches 158° F. claiming that if this is done the coagulated albumin remains suspended in the whey, and that it rises or settles if lower or higher temperatures than this are used. Very efficient results were being secured as shown by the bacterial reductions and the whey was being returned to the farmers in excellent condition with a predominant *B. bulgaricus* flora.

Samples were taken from Factory G on September 29, 30 and October 1, all of these being cool fall days. The equipment and

TABLE VII.— EFFICIENCY OF WHEY PASTEURIZATION AT FACTORY F, BY DIRECT STEAMING IN WHEY TANK.

Sample No.	Time taken.	Material.	Temperature.	Plate count.	Notes.
		September 27, 1915.	*Degs. F.*		
170	7:45	Raw milk	.....	4,450,000	
171	7:45	Pasteurized whey. Stood over night.	.....	*24,500,000	*B. bulgaricus* predominant. Acidity .32 per ct. lactic acid.
172	10:30	Raw whey	100	3,000,000	
173	11:00	Steamed 30 minutes in tank	123	2,400,000	
174	11:30	Steamed 60 minutes. Second vat run in	131	450,000	
175	12:50	Steamed 40 minutes. Steam shut off	158	7,600	
176	1:05	Same. Stood 15 minutes	157	5,500	
177	1:35	Same. Stood 45 minutes	153	4,500	
178	2:05	Same. Stood 75 minutes	150	4,500	
179	2:35	Same. Stood 105 minutes	148	2,000	
		September 28, 1915.			
180	8:15	Raw milk	.....	17,000,000	
181	10:40	Raw whey	100	6,450,000	
182	12:00	Steamed in tank about 30 minutes.	136	4,780,000	
183	12:30	Steam off 15 minutes	134	12,000	
184	1:10	Steam on 40 minutes more	158	1,250	
185	1:25	Steam off. Fifteen minutes later	157	1,050	
186	2:25	Same. Stood 45 minutes	150	12,000	
187	2:55	Same. Stood 105 minutes	146	9,500	

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* The two days of extra incubation at 37° C. increased this count from 153,000 to the figure given because the predominant organism did not appear until after the incubation at the warmer temperature.

arrangement of this factory were the same as those at Factory F except that the whey tank was on a level with the surface of the ground and a measuring device was in use which gave the cheesemaker control over the amount of whey received by each patron. The maker at this factory made it a practice to heat the whey to 155° F.

An unusual condition of the whey was shown on the bacteriological analysis of the samples taken on September 29 and 30. As will be seen in Table VIII this whey contained large numbers of *B. bulgaricus* as drawn from the making vat and even after heating to 156° it still showed these bacteria in large numbers. All of the whey samples taken on September 29 showed these colonies but they did not appear on all of the plates made from the samples taken on September 30. It is quite probable that this organism was present in all cases, however, as other instances of the sort occurred where they failed to develop. The failure to secure a high percentage reduction in numbers of bacteria on these two days does not, therefore, indicate that the pasteurization was necessarily unsatisfactory but merely that for some reason the whey as drawn from the vats contained large numbers of *B. bulgaricus* and these organisms persisted, as they are very heat-resistant. It would have been interesting to follow the history of the cheeses made on these days in order to see whether they differed in any way from those made on October 1 where the development of acidity in the milk from which the cheese was made was apparently due to the ordinary lactic acid bacteria.

Samples of old, unpasteurized whey were taken from a single Factory (H). At this place the whey tank was located outside of the factory on a level with the surface of the ground and was covered with a rough shed. The whey was allowed to run into the tank by gravity without pasteurization. The appearance and odor of the tank were those of an old swill barrel which had never been cleaned. The whey was pumped from the bottom of the tank each morning, allowing the fat which had risen to the top during the night to settle to the bottom of the tank. Each day more fat had accumulated until it had become an unsightly and foul-smelling mass. The average plate count of three samples of this whey taken October 12 was 4,000,000. A microscopic examination showed, however, that this was only a small proportion of the bacteria present and that the two predominant organisms had both failed to develop, namely *Bacillus bulgaricus* and a yeast, presumably of the lactose-fermenting type. The microscopic count showed 1,500,000,000 *B. bulgaricus* and 30,000,000 yeasts per cubic centimeter. A test of the acidity showed 1.125 per ct. lactic acid. The figures show that the unpasteurized whey had not only developed a much greater acidity than pasteurized whey under similar conditions but also that it contained a greater number of miscellaneous bacteria and yeasts. The presence

Table VIII.— Efficiency of Whey Pasteurization at Factory G, by Direct Steaming in Whey Tank.

Sample No.	Time taken.	Material.	Temperature.	Plate count.	Notes.
		September 29, 1915.	*Degs. F.*		
188	7:15	Raw milk	.....	310,000	
189	7:15	Pasteurised whey. Stood all night.	.....	*2,000,000	Acidity .39 per ct. lactic acid.
190	11:10	Raw whey	100	*16,300,000	
191	11:45	Whey steamed about 30 minutes	136	*18,600,000	*B. bulgaricus* persisted through the entire series. Other organisms were nearly all killed by the pasteurization.
192	12:00	Whey steamed about 45 minutes	146	*9,240,000	
193	12:10	Whey finished pasteurization	154	*5,550,000	
194	12:25	Same. Stood 15 minutes	151	*9,660,000	
195	12:55	Same. Stood 45 minutes	146	*9,090,000	
196	1:25	Same. Stood 75 minutes	142	*9,280,000	
197	1:55	Same. Stood 105 minutes	139	*5,300,000	
		September 30, 1915.			
198	7:15	Raw milk	.....	290,000	
199	7:15	Pasteurised whey. Stood all night.	.....	*17,250,000	Acidity .51 per ct. lactic acid.
200	11:15	Raw whey	100	5,400,000	
201	12:20	Whey steamed about 30 minutes	136	3,930,000	*B. bulgaricus* colonies did not develop on all plates, but they were probably present in all of the whey samples.
202	12:45	Whey steamed about 45 minutes. Steam off 15 minutes	136	*4,400,000	
203	1:00	Whey finished pasteurising	156	1,800,000	
204	1:15	Same. Stood 15 minutes	152	*8,400,000	
205	1:45	Same. Stood 45 minutes	148	*2,000,000	
206	2:15	Same. Stood 75 minutes	144	*1,600,000	
207	2:45	Same. Stood 105 minutes	142	*750,000	
		October 1, 1915.			
208	7:00	Raw milk	.....	7,550,000	
209	7:00	Pasteurised whey. Stood all night.	.....	*12,600,000	Acidity .38 per ct. lactic acid. *B. bulgaricus* predominant.
210	11:20	Raw whey	100	5,560,000	
211	1:10	Whey finished pasteurising	156	574,000	
212	1:25	Same. Stood 15 minutes	154	29,300	
213	1:55	Same. Stood 45 minutes	150	36,000	
214	2:25	Same. Stood 75 minutes	146	8,000	
215	2:55	Same. Stood 105 minutes	142	1,350	

* The two days of extra incubation at 37° C. increased these counts from low numbers to the figures given because the predominant organism did not appear until after incubation at the warmer temperature.

of yeasts in unpasteurized whey from Wisconsin cheese factories has also been reported by Hastings.[22a]

A study of the temperature records shows that only one factory out of the seven visited used a temperature sufficiently high to meet the requirements of the Pennsylvania law (178° F.). At this one factory (A) this temperature was reached on 4 days out of the 41 days on which temperature records were kept. On the other hand all of the factories except two (B and C) used a sufficiently high temperature to meet the low requirements of the Michigan law (145° F. for 30 minutes). Two factories failed to reach this temperature on eight days out of the twelve days for which records were kept. Both of these were using the double-jetting system of pasteurization.

The bacterial analyses and temperature records show that Factories A, E, F, and G were undoubtedly securing satisfactory results in killing the tubercle bacillus and other disease germs. A question might be raised in regard to Factory G because of the fact that the bacterial reduction was not as great as might have been expected from the temperatures used on two days (September 29 and 30). The high counts in the pasteurized whey, however, were due to *B. bulgaricus* which is able to stand much higher temperatures than the tubercle bacillus, so that this low efficiency is apparent rather than real.

On the other hand, the results secured at Factories B, C and D could hardly be classed as satisfactory on any of the days when temperature records were taken. In some cases the temperature used was not high enough, in others the addition of separator slop and washings or of cold water to dilute the whey spoiled what would otherwise have been satisfactory results.

Perhaps the most interesting thing that was discovered in the course of this investigation is the character of the organisms which occur in pasteurized and unpasteurized whey. In the course of the work, fifteen samples of old pasteurized whey were taken from the seven factories. Twelve of the samples gave plate counts in the tens of thousands on the fifth day after incubation at 21° C. Two days later, after incubation at 37° C., these same plates showed innumerable fine ragged colonies which resembled a precipitate in the agar and might easily have been overlooked. The first time this occurred, it was suspected that these were *B. bulgaricus*[22b] colonies and, later, microscopic examination of the whey and cultural and microscopic examination of the organisms in the colonies confirmed this suspicion. Three of the samples of old pasteurized whey (Factory C, August 23, Factory D, August 25, and Factory E, August 30) failed to show characteristic *B. bulgaricus* colonies on the plates even after the extra incubation. However, the failure of *B. bulgaricus* to appear on the plates in these cases does not prove that it was absent. In fact in one case, that of August 25, microscopic examination of the whey showed it to be filled with this organism.

[22a] Hastings, E. G. Distribution of lactose-fermenting yeasts in dairy products. Wis. Agrl. Expt. Sta. 33rd Ann. Rpt., pp. 107–115. 1906.

The conditions under which the pasteurized whey is kept are particularly favorable for this organism. It is an organism with a high thermal death point and its optimum temperature for growth (113 to 122° F.) is high. Through this ability to withstand high temperatures some individuals survive the pasteurization and, as the whey cools, these find both optimum temperatures and an abundant food supply. Thus in the 4 cases where the whey which had stood over night was tested for acidity, these organisms had already developed .39, .38, .51 and .32 per ct. acidity, calculated as lactic acid. Under these conditions, the farmer fills his milk cans with a nearly pure culture of this organism which must continue to grow there and soon develops sufficient acidity to sour the whey. As is well known, cultures of this organism have a favorable influence on digestive processes and this fact, together with the lessened acidity, undoubtedly helps to make the pasteurized whey a better feeding material than unpasteurized whey.

Likewise, it is entirely probable that the filling of the milk cans with cultures of this organism is far from having an unfavorable influence on the quality of the cheese produced from the milk returned to the factory in the same cans on the following morning. In fact this may have been the source of the *B. bulgaricus* which occurred in the making vat at Factory G on September 29 and 30. This organism is an essential organism in the making of swiss cheese[23] and has been shown to play a part in the ripening of cheddar cheese.[24] The development of this practically pure culture of *B. bulgaricus* in pasteurized whey may well be the cause of the improvement in the quality of the cheese which has been noted[25] after pasteurization has been introduced.

[22b] This name is used as a matter of convenience to designate bacteria of the long rod, lactic-acid group as distinct from bacteria of the short rod, streptococcus-like, lactic-acid group commonly known as *Bacterium lactis acidi*. See Hastings, E. G., and Hammer, B. W. The occurrence and distribution of a lactic acid organism resembling the *Bacillus bulgaricus* of yogurt. Wis. Agr. Exp. Sta., 25th and 26th Ann. Rep. 1908 and 1909, p. 197-206, 1910.

Unfortunately, only one chance was found to obtain samples of unpasteurized whey under conditions similar to those just described. In this case as already described (pages 228–30) the conditions in the whey tank at the time the farmers secured their whey were as bad as they possibly could be. The organisms present were of a mixed lot with a predominant *B. bulgaricus* flora but with very large numbers of a yeast and of other organisms. The presence of the yeast in addition to the *B. bulgaricus* was especially interesting as no instance had been noted where such organisms were seen in the pasteurized whey. If time had permitted, this finding would have been investigated farther, as yeasts are suspected to cause sweet flavors and other "off-flavors" of cheese.[26] Because of the fact that the yeast failed to develop on the plates it could not be isolated for further study and identification.

CAUSES OF INEFFICIENT PASTEURIZATION.

One practice which seems general in those cheese factories which make whey butter is that of adding the separator slime and wash water to the whey. This is usually done after the whey has been heated and has begun to cool so that the added material is not sufficiently heated to pasteurize it. This is a very unsatisfactory practice, as such material is richly supplied with bacteria. The addition of this material to the pasteurized whey made a marked difference in the plate count made from the whey in all of those cases where this condition was present. (Factory B, C and D.)

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[23] See the following for a recent discussion of the part played by *Bacillus bulgaricus* in the making of swiss cheese and for references to the most important papers on the subject.

Doane, C. F., and Eldredge, E. E. The use of *Bacillus bulgaricus* in starters for making Swiss or Emmental cheese. U. S. Dept. Agr., Bul. 148, 16. pp. 1915.

[24] Hastings, E. G., Evans, Alice C., and Hart, E. B. Studies on the factors concerned in the ripening of cheddar cheese. Wis. Agr. Exp. Sta., Res. Bul. 25, 54 pp. 6 figs. 1912.

[25] Page 15 in first reference given in footnote 4.

[26] Harding, H. A., Rogers, L. A., and Smith, G. A. Notes on some dairy troubles. N. Y. Agr. Exp. Sta. Bul. 183, pp. 173–193. 1900.

Russell, H. L., and Hastings, E. G. A swiss cheese trouble caused by a gas forming yeast. Wis. Agr. Exp. Sta., Bul. 128, 26 pp., 10 figs. 1905.

Another unsatisfactory practice is caused by the fact that patrons often show a liking for more than their share of the whey. Since the operator frequently has no way of checking up the amount of whey taken, he usually meets the difficulty by adding sufficient water to give all the whey desired. This dilutes and cools the whey, making the pasteurization unsatisfactory in many cases. One factory, as a remedy for this condition, installed one of the simple systems of checking up the amount of whey taken by each patron.

Another cause of inefficiency, which was found especially in those factories which used the double-jetting system of pasteurization, was uncertainty in getting sufficiently high temperatures to pasteurize. The whey may be heated hot enough to pasteurize at the second jet pump but cools in running through the pipes to the whey tank or is cooled by the tank itself. The latter condition is especially troublesome in cold weather. Since factories which have the double-jetting system rarely have any supplementary system by which the whey in the tank can be heated, they usually pasteurize very inefficiently. These conditions may be remedied by better insulation of the pipes and tank or, better, by running a steam pipe into the whey tank. The double-jetting system of pasteurization has one marked advantage in that a careless or unreliable operator cannot fail to use it.

A method by which thoroughly satisfactory results can be secured under all conditions is that of steaming the whey in the tank whether combined with jetting or alone. With sufficient boiler capacity, the whey can be heated to any required temperature at a very low cost. Sufficiently high temperatures were also obtained very easily and satisfactorily by means of the Victor pasteurizer.

B. SKIM MILK PASTEURIZATION.

The satisfactory pasteurization of skim milk is a somewhat different problem from that of pasteurizing whey. In the majority of cases the skim milk is returned to the patrons immediately after separation and on the same morning that the milk is delivered. This ordinarily necessitates the use of a flash pasteurization system. The milk is usually turned back to the patrons hot because of the added expense involved in cooling.

It was not surprising to find that the pasteurization was very poorly carried out at one of the skimming stations which was visited. Samples were taken at this factory (I, see Table IX) on two consecutive days. Three sets of samples were taken on each day at different periods during the pasteurization process. A Reid flash pasteurizer was in use and the skim milk was pumped into a tank after pasteurization. The patrons drew the warm milk from this tank into their unsterilized milk cans. The temperature stated to be in use for pasteurization was 160° F. but on the first day on which samples were taken the temperatures ranged between 143 and 152° F. On the second day, higher temperatures were used, by request, ranging from 144° to 170°. Gross contamination of the pump, pipes or tank or of all of these is indicated by the results secured on the first day. It is interesting to note that this contamination became less and less as the process was continued, a result undoubtedly due to the washing and pasteurizing effect of the hot milk. The results obtained on the second day likewise indicate the con-

TABLE IX.—EFFICIENCY TESTS OF SKIM MILK PASTEURIZATION AT FACTORY I BY MEANS OF A REID FLASH PASTEURIZER.

Sample No.	Time taken.	Material.	Temperature.	Plate count.
		September 23, 1915.	*Degs. F.*	
217	....	Raw skim milk	....	1,050,000
218	7:20	Pasteurized skim milk	152	63,000
219	....	Pasteurized skim milk after pumping	....	1,210,000
220	....	Raw skim milk	....	5,400,000
221	7:50	Pasteurized skim milk	143	450,000
222	....	Pasteurized skim milk after pumping	....	970,000
223	....	Raw skim milk	....	7,000,000
224	8:15	Pasteurized skim milk	144	480,000
225	....	Pasteurized skim milk after pumping	....	251,000
		September 24, 1915.		
226	....	Raw skim milk	....	18,500,000
227	7:20	Pasteurized skim milk	144	560,000
228	....	Pasteurized skim milk after pumping	....	450,000
229	....	Raw skim milk	....	1,000,000
230	7:45	Pasteurized skim milk	162	8,500
231	....	Pasteurized skim milk after pumping	....	55,000
232	....	Raw skim milk	....	420,000
233	8:15	Pasteurized skim milk	170	500
234	....	Pasteurized skim milk after pumping	....	1,600

tamination of the same utensils but they caused less increase in the count because the hotter temperatures killed more bacteria.

A large butter factory and by-products plant (Factory J) which turns some skim milk back to the patrons was visited. At this plant, which was arranged similarly to several other plants operated by the same company, the skim milk from the separators is pumped through about 60 feet of two-inch pipe to a tank on the second floor where it is heated with a Wizard agitator to a temperature of 150 to 160° F., held at that temperature 30 minutes, cooled by running water to about 50° F. and given back to the patrons the next morning after standing about 20 hours. Bacteriological analysis of samples taken on November 23 during this process gave the following results:— raw skim milk, 616,000 per cubic centimeter; heated to 155° F., 162,000; held at 155° F. for 30 minutes, 43,000; cooled and stood 20 hours, 75,000.

The two-inch delivery pipe was sterilized each day by blowing steam through it. The steam was admitted through a ¾-inch pipe near the pump. As an experiment the steam was turned into the pipe when skim milk was being pumped to the pasteurizing tank. At that time one separator with a capacity of 3,500 pounds per hour was running. The milk from this separator was heated, by opening the steam valve very little, so that it had a temperature of 175 to 180° F. as discharged from the pipe 60 feet from the steam connection. The raw skim milk at this time gave a count of 1,500,000. After heating as described, standing in the tank a few minutes and being drawn into an unwashed milk can at a temperature of 146° F. the count was 29,200, a percentage reduction of 98. This same can of milk after standing 30 hours in the factory at a temperature of about 70° F. was not sour, but microscopic examination showed large numbers of bacteria present, principally *Bacterium lactis acidi* with some *Bacillus bulgaricus* and other forms. At the end of 48 hours the milk had curdled and a microscopic examination showed that *B. bulgaricus* had become the predominant form.

A device[27] similar to the one recommended by the Pennsylvania State Livestock and Sanitary Board was installed at Factory K (shipping and skimming station combined). This device consists of a steam jet pump to lift the milk and an additional steam pipe connected to the discharge in such a way that more steam can be added to the milk after it is past the jet, thus heating it to the required temperature. The jet pump used in this instance was too large for the supply of skim milk and could not be operated continuously, but, by allowing a surplus to accumulate, a temperature of 180° F. could be obtained. A smaller pump or sufficient milk to allow continuous operation would have overcome this difficulty. In this case an objection to the device arose because of the froth produced on the milk. This made it difficult to fill the cans. Various devices or arrangements of piping might have been used [28] to overcome this difficulty if time had permitted the attempt to be made.

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[27] See footnote 7.

So far as these studies show, there are two general methods of pasteurizing skim milk satisfactorily. One is the holding process with subsequent cooling, returning the milk to the patrons the next morning. This is a comparatively expensive process because of the cost of equipment and cooling, and one which may give unsatisfactory results unless carefully controlled. Another method is to heat by the flash system, using either a regular market milk pasteurizer or a device by which the condensed steam is added to the skim milk. Where the milk is heated and turned back immediately, the most satisfactory procedure is to turn the skim milk into the patrons' cans at a temperature that will remain above 145° F. for 30 minutes or more. This will destroy the greater number of the bacteria remaining in the can and the milk will remain in good condition long enough for convenient feeding. If the farmer cools the milk in the cans after returning to the farm, the keeping qualities of the milk will be increased.

Fears have been expressed that pasteurization at these high temperatures would kill the lactic acid bacteria and cause the development of undesirable putrefactive organisms in the pasteurized skim milk. This was not the case in the single instance where the matter was tried and there is good reason to believe that *B. bulgaricus* would ordinarily develop in the hot skim milk as has been shown to be the case with pasteurized whey.

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[28] Page 5 in second reference given in footnote 4.

REPORT

OF THE

Department of Botany.

F. C. Stewart, *Botanist.*

W. O. Gloyer, *Associate Botanist.*

[1] M. T. Munn, *Assistant Botanist.*

[2] Arthur J. Mix, *Assistant Botanist.*

[3] F. M. Blodgett, *Associate Botanist.*
(Connected with Hop Culture Investigations.)

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III. The spindling-sprout disease of potatoes.
IV. Potato-spraying experiments at Rush in 1914.
V. *Ascochyta clematidina*, the cause of stem-rot and leaf-spot of clematis.

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[1] Absent on leave from September 30.
[2] Appointed October 1.
[3] Resigned May 1.

REPORT OF THE DEPARTMENT OF BOTANY.

FURTHER STUDIES ON THE SPREAD AND CONTROL OF HOP MILDEW. *

F. M. BLODGETT.

SUMMARY.

1. Hop mildew first caused serious damage to hops in New York State in 1909, since which time it has gained steadily in importance and become a constant menace to the crop.

2. The perithecia or winter fruit-bodies of the hop-mildew fungus have been found to reach maturity in March and have been shown to be capable of causing infection in the greenhouse at that time of the year.

3. In artificial inoculation experiments, the time elapsing between the sowing of spores of hop mildew on hop leaves and the appearance of a fair-sized mildew spot was found to be about ten days.

4. It has been observed, also, that fresh mildew spots appear in approximately ten days after each rain. This leads to the inference that infection occurs during periods of wet weather, and indicates the advisability of applying sulphur as soon as possible after such periods in order to destroy the developing colonies of mildew.

5. During the past three years there have been made a considerable number of experiments in which flowers of sulphur, heavy flour sulphur and fine flour sulphur have been compared with respect to their efficiency in the control of hop mildew. In 1912 and 1913, control with all three kinds of sulphur was so nearly perfect that little difference could be detected even though the loss from mildew on the untreated plats ranged from 50 to 100 per ct. In 1914, conditions were generally more unfavorable for sulphuring and the tests of different kinds of sulphur therefore more severe. Under these conditions the average percentage of hops free from mildew on the unsulphured portions of six yards was only 5, while on the treated portions it was 78. The percentage of hops so badly mildewed as to be worthless on the unsulphured portions of the six yards was 61 while on the sulphured portions it was only 5.

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* A reprint of Bulletin No. 395, February, 1915.

The average percentage of hops free from mildew on the portions of these yards treated with flowers of sulphur was 68, on the portions treated with heavy flour sulphur 82 and with fine flour sulphur 83.

6. Flowers of sulphur has been found to be very variable in mechanical condition. Some it was impossible to apply satisfactorily. This sulphur in poor condition has been found to contain considerable amounts of sulphuric acid, which appears to be the cause of the trouble. Extremely fine flour sulphur has proven rather difficult to sieve and apply. Flour sulphur of a medium degree of fineness seems to be equally efficient, easier to handle, and cheaper. Coarse flour sulphur containing little or no fine sulphur is to be avoided.

7. Practical control has been successfully accomplished on a large scale by hop growers' cooperative associations. About seventeen hundred acres of hops have been included in such work within the last three years. The average amount of sulphur used per acre for the season has been approximately 190 pounds. There has been a large variation in the amount necessary to secure control in individual yards and also in the same yards in different years. The average for the Waterville association in 1912 was 165 pounds of sulphur per acre, in 1913, 160 pounds, and in 1914, 249 pounds. The average expense of sulphuring has been about eight dollars per acre per season.

INTRODUCTION.

CONTINUED IMPORTANCE OF THE DISEASE.

The appearance of the hop mildew (*Sphaerotheca humuli*) in a few hop yards in 1909 has been followed each year by reports of damage done in new districts, until, in 1912, no hop growing district in New York State seemed to have been missed although these districts are rather widely separated. It was first reported in Waterville in 1909;[1] in 1910, it was quite serious also at Middleburg; in 1911, it became serious in the Milford valley and about Cooperstown; and in 1912 it did serious damage about Malone in the extreme northern part of the State and in the hop-growing section about Canandaigua lake, both comparatively isolated districts. During 1913, badly mildewed leaves and hops were received from a hop grower in Fournier, Ontario, Canada, who had lost about four tons of hops. The disease was noticed in that section for the first time about July 27 of the same year.

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[1] An account of the early history of hop mildew in New York is given by Stewart and Whetzel on p. 356 of Bulletin 328 of this Station.

The damage by mildew was probably greatest in 1912. During that year the losses in New York State could scarcely have been less than one-third million dollars. In 1913 conditions were much better, yet heavy losses occurred in some districts where little sulphuring had been done. Although the year 1914 proved to be one in which the mildew was difficult to combat, the writer believes that the average losses due to mildew were little if any greater than in the year previous. In fact, in some sections, the control was decidedly better, due to the extension of sulphuring operations. That such an extension actually occurred is evidenced by the fact that more than eighty new dusting machines were put in operation and about one-half more sulphur was used in the State than during the year previous.

INJURY BY HOP APHID IN 1914.

Unfortunately, the latter part of the season of 1914 proved favorable also for the hop aphid. Early in the season this insect seemed comparatively scarce in most yards, but late in July and throughout August, its numbers increased rapidly. At this time the hops were formed and the aphids in many cases had penetrated between the bracts, so that it seems doubtful whether effective spraying could have been done after the conditions had become at all alarming. Once inside the hops, the aphids continued to increase up to picking time, producing the usual honey-dew, accompanied by a black mold. This mold and honey-dew seriously affected the appearance of the hops and where the aphid attack came early the hops were much dwarfed. Thus, the aphid contributed to make the 1914 crop of hops for New York, the poorest for several years.

SCOPE OF THIS WORK.

The work reported in this bulletin is a continuation of investigations and experiments conducted under the direction of Cornell University Station from 1910 to 1912 and published in Bulletin No. 328 of that station. It has seemed desirable to continue the testing of control measures in order to learn under what conditions they will prove effective and whether they may be relied upon under the different weather conditions always experienced in a period of several years. At the same time, some studies and observations have been made on certain phases of the life history of the mildew fungus, which, it is believed, have an important bearing on the method of control. Practical control measures have been carried out on a large scale by hop-growers in cooperative associations. Statistics of this work are thought to be valuable as a measure of the practicability of these control methods. These things are here considered because it is believed that they will contribute to a better understanding of the disease and its control.

OBSERVATIONS ON LIFE HISTORY OF THE FUNGUS.

MATURATION AND DEHISCENCE OF THE PERITHECIA.

Salmon[2] has described the dehiscence of the perithecia of this fungus. He gathered hop leaves bearing perithecia in January and found that, after they had been kept three or four months in the dry condition, they would dehisce if placed in water. The writer has found, on the contrary, that perithecia on leaves and hops collected during the springs of 1913 and 1914 were in condition to dehisce at once without being kept under dry conditions. When collected early in the winter they dehisced better if kept out of doors under as nearly natural conditions as possible. Parts of vines bearing mildewed hops and leaves were collected in two localities on April 4, 1913. Most of these were taken from vines that had been stripped from the poles and lay in piles on the ground over winter. When brought into the laboratory on April 6, perithecia from both lots were found to be in a condition to dehisce at once; and when last tried, on May 21, they were still capable of dehiscing.

During the winter of 1913–14 several lots of perithecia were secured that were capable of dehiscence. One lot, collected about the middle of November from hops grown in the greenhouse, was placed out of doors in a protected place. Another collected near Index on December 10 from a yard ruined by mildew, was divided into two parts, one of which was placed out of doors, and the other kept in the laboratory. Trials made early in December with perithecia from the hops taken from the greenhouse and placed out of doors in November indicated that some were nearly ready to dehisce. That is, the perithecial wall burst in a number of cases and the ascus inside swelled to the dimensions usually attained before the expulsion of spores. However, dehiscence did not actually take place in any observed instance. Leaves of the same lot bearing perithecia were brought into the laboratory on January 20. At this time, within ten minutes after placing in water, many perithecia were found with their walls split at the apex and the asci swollen to the size of the original perithecia. From a few the spores had been discharged at the end of thirty minutes.

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[2] **Salmon, E. S. Notes on hop mildew (*Sphaerotheca Humili* (DC.) Burr.). *Jour. Agr. Sci.* 2:327–332. 1907.**

Of the hops collected at Index on December 10 and placed out of doors at Ithaca, some were brought in on February 20, but the perithecia did not seem ready to dehisce immediately. When they were placed on moist blotting paper in a petri dish, dehiscence took place in the course of three days, and spores were found on a slide suspended above them. Others brought in on March 24 and treated similarly were found to have dehisced on the 26th and in some instances the ascospores had germinated and the germ tube had grown to two or three times the length of the spore. Dehiscence took place more rapidly in the case of perithecia from hops left out of doors until April 14.

Another lot of leaves and hops bearing perithecia was collected from the same field at Index on March 27, 1914. These dehisced readily on being brought to the laboratory and placed in water.

Frequent trials were made during the two years with perithecia from leaves and hops brought into the laboratory and left several weeks in the dry condition. No improvement in the dehiscence was ever noticed from this treatment. Perithecia which were not capable of dehiscing when brought into the laboratory did not become so later by being kept in a dry condition.

These observations seem to indicate that perithecia are mature and ready to discharge the spores which cause infection as soon as the weather is sufficiently warm and moist.

The manner of dehiscence of perithecia has been repeatedly observed by the author. Within a few minutes after being placed in water, the perithecia begin to split at the apex. The tip of the ascus immediately slips out through this slit pushing it wider open. The ascus continues to swell, though apparently restrained by the friction of the walls of the perithecium, until sufficient pressure is developed to enable it to slip farther out, usually with a rather sudden movement. However, the basal end of the ascus remains within the perithecium throughout the process of dehiscence as described by Salmon. Frequently, the splitting of the perithecium and the swelling of the ascus to near the bursting point occupies only a few minutes. Usually a longer period, sometimes a half hour or more, then elapses before sufficient tension is developed to effect the rupturing of the tip of the ascus. The spores are then suddenly shot out and the ascus collapses, allowing the perithecium to close partially.

In April, 1913, a few tests were made to determine the height to which spores are shot. Pieces of old leaves and hops were placed in the bottom of a moist chamber with slides supported above them. In one case where a slide was placed so as to be 5 millimeters above the perithecia at one end and 9 millimeters at the other, spores were caught throughout its length. In another case they were caught on a slide 1 centimeter above the perithecia, but much more abundantly on another slide at a height of 5 millimeters. Frequent cases were recorded where the spores were shot to a height of 5 millimeters.

INOCULATION EXPERIMENTS WITH ASCOSPORES.

The inoculation experiments here recorded were made on hop plants in a greenhouse at Ithaca. In the spring of 1913 two series of inoculations were made — one with ascospores caught on glass slides placed above perithecia, the other with the perithecia themselves. Two others, with perithecia, were made in the spring of 1914. In all four series of inoculations both the inoculated plants and the check plants were covered with bell jars for about 36 hours after inoculation. No mildew occurred on any of the check plants and there was no mildew on any hop plants in the greenhouse previous to the time of the first inoculation in either year. The perithecia used for inoculation were taken from hop leaves over-wintered out of doors. Spots became visible on inoculated leaves in 7 or 8 days in each case. At the end of 10 days or 2 weeks, the spots had increased in size so as to be easily seen at some distance and were comparable in size with spots easily discoverable in the field. Such a spot 10 days old as seen through a microscope is shown in Plate X, fig. 1. The mycelium showing faintly may be seen spreading in

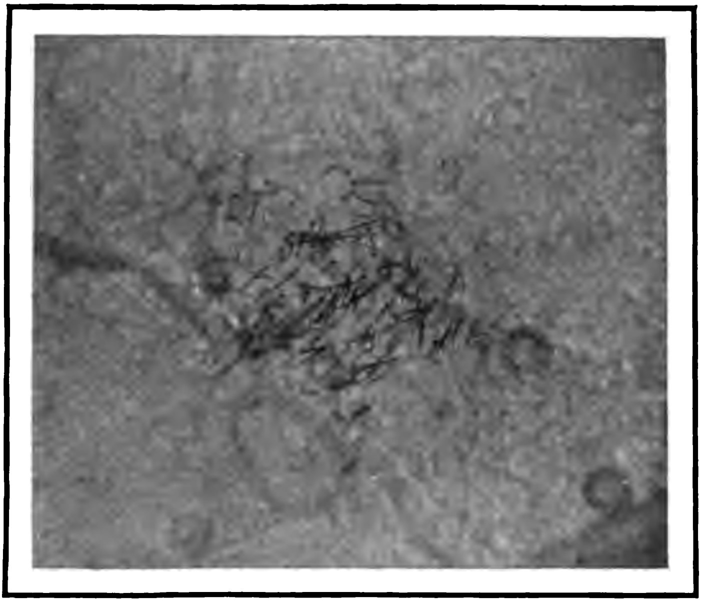

Fig. 1.—Hop Mildew Spot Ten Days Old.
(Magnified 50 times.)

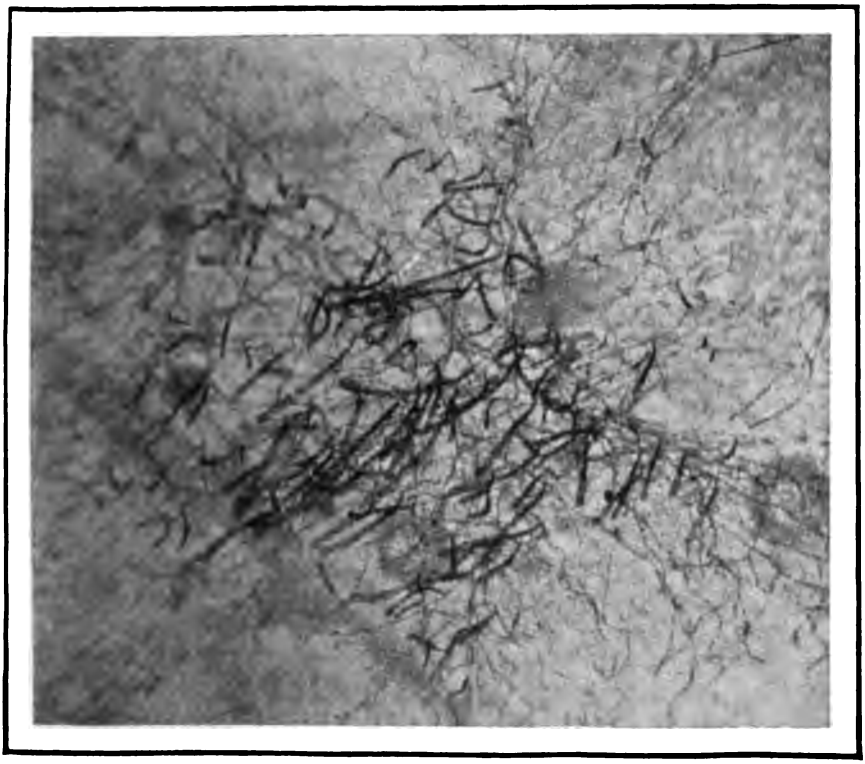

Fig. 2.—Hop Mildew Spot Ten Days Old.
(Magnified 95 times.)

Plate X

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all directions from a common center. In the center of the spot could sometimes be discovered the ascospore from which the spot started with four or five mycelial strands running out from it. The mature conidiophores may be seen in Plate X, fig. 2 in the center of the spot with a gradation to the youngest beginnings of conidiophores toward the periphery of the spot. The branching mycelium extends far beyond the point where conidiophore formation has begun. Earlier examinations of leaves, inoculated at the same time, showed that at the end of three days conidial formation had not yet begun in most instances, but that the spot consisted of fine mycelial filaments spreading and branching in every direction from the original ascospore. At the end of six days, the mycelium had spread and branched more extensively and usually a few (5 to 10) conidiophores had been formed in the center. The formation of conidiophores is the principal factor in making the mildew spots apparent to the eye.

HOP MILDEW AND STRAWBERRY MILDEW.

An interesting observation was made during the early part of the season of 1914. On a hop farm near Cooperstown, part of the yards had been plowed up two or three years previously and on about an acre of this land strawberries had been set in 1913. At the same time, as is usual, many of the old hop roots had not been entirely removed, so that living hop plants were scattered through the yard among the strawberries. On June 12 the writer's attention was directed to this bed of strawberries which at that time appeared severely affected with powdery mildew. Search was then made of the bearing hop yards remaining on the place and also of the vines intimately entangled with the strawberries without finding any mildew yet on the hops. The fact that the strawberries were so thoroughly infested with mildew when none could be found on the hops interwoven with them indicates that the mildew on the strawberry is a different biologic form of *Sphaerotheca humuli* from that on the hop. This is in accord with the view, now generally accepted, that the hop mildew is a specialized biologic form which is confined to the hop and its near relative, *Humulus japonicus*.[3]

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[3] Salmon, E. S. On the specialization of parasitism in the Erysiphaceae II. *New Phytol.* 3:118–121. 1904.

Salmon, E. S. Notes on the hop mildew (*Sphaerotheca Humuli* (DC.) Burr). *Jour. Agr. Sci.* 2:330–332. 1907.

Steiner, J. A. Die Spezialisation der Alchimillen-bewohnenden *Sphaerotheca Humuli* (DC.) Burr. *Centbl. Bakt.* [etc.] 2:21:677–736. 1908.

RELATION OF SPREAD OF MILDEW TO WEATHER.

REVIEW OF LITERATURE.

In the early history of this disease, as probably with most others, many and varied were the attempts to ascribe it to some kind of weather. This proved easy enough for one year at a time, but in the course of time, as seasons varied, it has been charged against nearly all possible kinds of weather. To quote a few of these, Rutley[4] says, "The mold is most prevalent in moist and warm summers." Paine[5] writes, "We believe it to be a parasitical vegetable fungus, usually generated in wet seasons and damp situations." Whitehead[6] in various papers has offered theories and observations. In 1881 he states, "It is commonly believed that the hop plant is predisposed, by an unhealthy and abnormal condition, to be affected by mildew or mould; . . . A sudden check, caused by spring frosts or cold weather, may bring about this predisposition." In a later paper (1887) he writes, "In 1860, the wettest summer of the present century, the entire crop upon thousands of acres was utterly ruined by it. In this last summer, one of the most dry of this century, many hop grounds yielded nothing on account of its attacks upon the cones." In 1910, Percival[7] writes, "If the nights are cold and damp and the hop plants in a backward or weakened condition, the patches soon increase in size." In another place in this article he seems willing to attribute the attacks of mildew to nearly any kind of weather; he says, "Anything which reduces the vitality of the hop — such as cold damp nights, long continued drought, or wet weather and lack of proper sunshine and fresh air — indirectly aids mold in its ravages." Salmon[8] speaking of *Sphaerotheca humuli* occurring on strawberry writes, "As regards the climatic conditions favorable to the disease, there seems to be a consensus of opinion among gardeners that these are to be found in

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[4] Rutley, Samuel. On the best mode of managing hops in its various branches. *Jour. Roy. Agr. Soc.* 9:532–582. 1848.

[5] Paine, J. M. Hop. A Cyclopedia of Agriculture, London (Blackie and Son), p. 57. 1856.

[6] Whitehead, Chas. Hops. p. 55. 1881.

Whitehead, Chas. The hop mildew or "mould," *Podosphaera castagnei* Lév. Ann. Rpt. Great Britain Agr. Advisor 1887:33–42.

[7] Percival, John. Hop mildew. Agricultural Botany, Theoretical and Practical. pp. 749–756. 1910.

[8] Salmon, E. S. The strawberry mildew (*Sphaerotheca Humuli* (DC.) Burr.). *Jour. Roy. Hort. Soc.* (London) 25:132–138. 1900–1901.

sudden alterations of temperature, especially in a decrease of temperature during the night, or a cooler temperature followed by hot weather." He also found that conidia germinated better after being cooled for a time. According to Norton[9] the spread of rose mildew is favored in the greenhouse by drafts of cool air coming in at ventilators, crevices, broken glass, etc. Bondarzew[10] concludes from germination and inoculation experiments with conidia of *S. humuli* on hop in May, when the temperature was low and the weather moist, and in June, when the temperature was high (20–25° C.) and weather moist, that warm, moist weather is favorable for the development of this fungus. Ward[11] in 1901 has expressed a similar opinion in regard to wet weather: "It is only in certain seasons, when the air is damp for some time, that these conidial segments are developed in any quantity, but when such is the case they are so numerous, and so easily carried from plant to plant, that no wonder need be expressed at the rapid spread of the disease; moreover it is in just such seasons that the hop leaves and 'cones' are particularly tender and watery, their cell walls thin, and their recuperative power low, whence we have other important factors favourable to the spread of the fungus. Finally, it is in such wet surroundings that the conidia meet with the best conditions for rapid germination."

OBSERVATIONS FROM 1912 TO 1914.

The writer has pointed out in a previous bulletin[12] that the appearance of new mildew spots on the hop seems to follow ten days or two weeks after the rainy periods. This conclusion was arrived at from two series of observations, one made at Waterville and the other at Milford during the year 1912. Similar records have now been made for the years 1913 and 1914 for two places in the hop-growing section of the State. These are charted in Figure 1 to show time and amount of rainfall and times of appearance of principal infections. The records at Cooperstown were made by the author; the others, by men engaged in inspection work for the hop growers' associations at Waterville and Milford.

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[9] Norton, J. B. S. Rose mildew. Maryland Sta. Bul. 156:76–78. 1911.

[10] Bondarzew, A. S. (In Russian.) The powdery mildew disease of hops and control experiments in a hop yard of Miskovsky of the Kostroma district. *Jahrb. Pflanzenkr.* (St. Petersburg) 2:16–28. 1908.

[11] Ward, H. M. The hop disease. Diseases of Plants pp. 153–155. 1901.

[12] Blodgett, F. M. Hop mildew. New York Cornell Sta. Bul. 328:290–291. 1913.

In Fig. 5, heavy horizontal lines separate observations for different places and for different years in the same place. Beginning at the top, there appears, above the first line, the record of rainfall and appearance of new mildew infections for Waterville in 1912, then below in order, Milford in 1912, Waterville in 1913, Cooperstown in 1913, Cooperstown in 1914 and Waterville in 1914.

The spaces between the light vertical lines represent periods of time of one day each. The heavy vertical lines divide the time into ten-day periods. The amount of rainfall occurring on each day is indicated by the height of the black areas; the distance to the first light line in each case representing a half inch and to the second line one inch. Rainfall not measured, but estimated, is represented by an outlined area containing an X. Mildew infections are represented by outlined areas.

By reference to the part of the chart representing Waterville for 1912, it will be seen that the first mildew infections were found appearing in a few yards on June 18 and 19, probably having started during a rain occurring on June 6. Many light infections were found in yards from the third to the sixth of July which seem to have started in the showers of June 20 and 21. Heavier infections appearing on July 15 and 20 appear to have started on July 4 and 9 respectively. For the remainder of the season, rains occurred more frequently and infections came closer together until, during the last of August and early September, it became quite impossible to distinguish between individual infections. During the latter part of the season observations were made in new yards. In general, it may be said of the season of 1912 at Waterville, that only a few mildew spots could be found till about the middle of July. At this time there seemed comparatively little danger to the crop from mildew. During the last of July and during August, however, the rate of increase was so rapid that many yards not sulphured, or sulphured little, were lost.

At Milford in 1912, the conditions were very similar. A few slight infections were observed on June 10. No record is available of the weather conditions previous to June 7, so during what rain this started is not known. Further infections appeared from June 18 to 20 as at Waterville, having started in the rain on June 6. A light shower on June 12 (which did not occur at Waterville) gave rise to mildew on the 25th. No observations were made during the

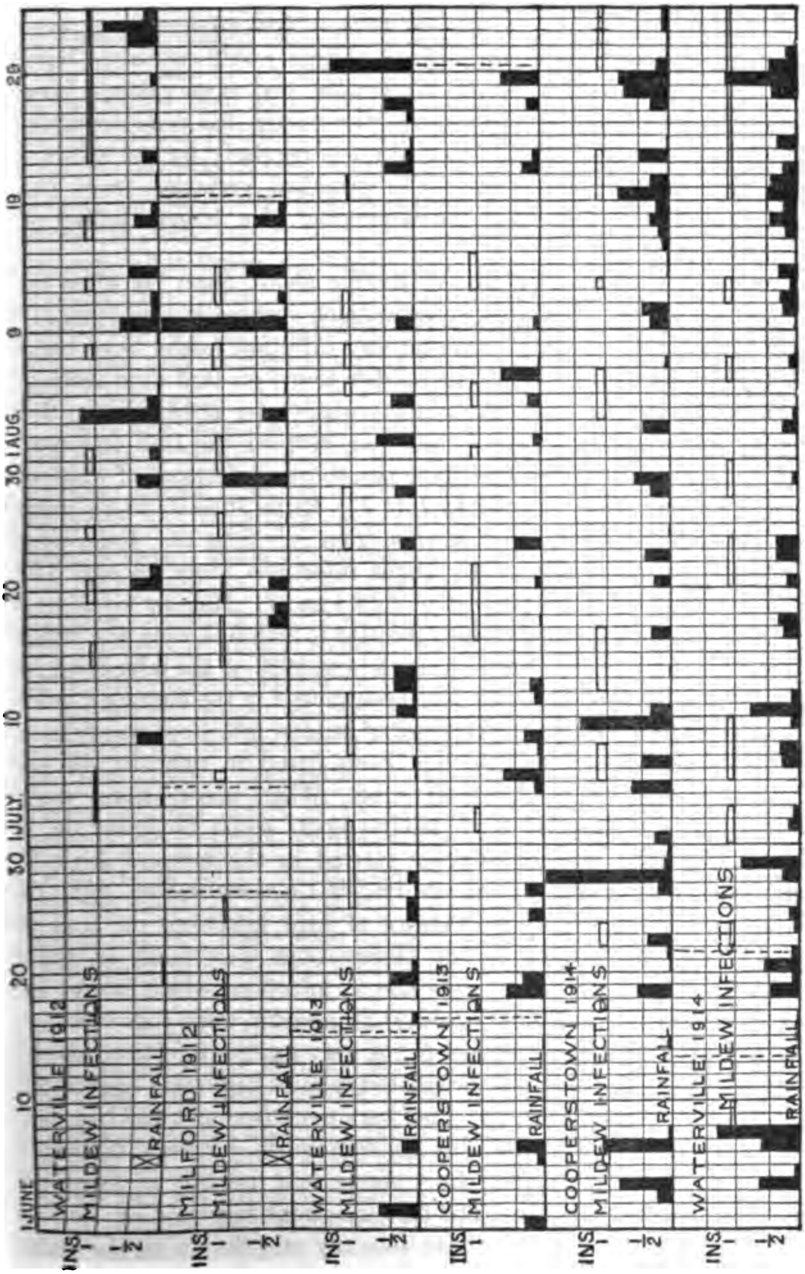

FIG. 5.—CHART SHOWING RELATION OF RAINFALL TO DEVELOPMENT OF MILDEW SPOTS.

period from June 27 to July 5 inclusive. New mildew spots were observed in many places on July 6. These would probably have been discovered earlier, as at Waterville, had observations been made. Throughout the remainder of the season, the rains occurred frequently, as at Waterville, followed quite regularly by the appearance of mildew in ten days. The principal variation from the condition at Waterville was the occurrence of a larger number of early infections.

In 1913, a visit was made to Waterville about June 1st when no mildew was found. No further observations were made until June 17. It is not known, therefore, whether any infection might have been found previous to the 17th. The mildew found on that date seemed to be comparatively fresh and could probably be attributed to the rain on the seventh of June. Light showers on the 15th followed by a week of showery weather gave rise to new infections of mildew which appeared from June 24 to July 1. Rains June 25 to 28 were followed by the appearance of mildew from July 8 to 12. Following this there appeared many very slight infections (July 18 and 19) probably traceable to the showers of July 6 and 7. Heavier infections were reported in a few cases from the 24th to 28th following the rains of July 11 and 14. No record was made in 1913 of the infections in the new yards after the hops had been picked in the bearing yards.

At Cooperstown, in 1913, no record of mildew infections was begun until June 17 though mildew had been found in quantity in an abandoned yard on the third of June. When observations were begun again on June 17, fresh mildew spots could be found in a number of yards, probably having started in the rains of June 6 and 7 as at Waterville. Rains occurred in Cooperstown on June 19 and 20 and there was some evidence of light infections on July 2 and 3 though comparatively few observations were made at that time. Rains on July 5 to 9 gave rise to infections which began to appear on July 17. Rains on July 21 and 24 were followed by infections on July 31 and August 5. A very general infection which began to appear on August 13 originated in rains beginning August 2.

At Cooperstown in 1914, the rains were more frequent and heavier so that it soon became difficult to distinguish between different infections. Accordingly, the chart shows only periods of heaviest and most general infection. The first infections recorded on June 6 apparently began at an earlier date than any rain shown on the chart and before any weather record had been begun. No further infections were recorded until June 18. These clearly started in the rains on June 7 and 8. A new, light, but more widely spread infection, appeared on June 23 and 24, having started in showers on June 15. A rain on June 19 would have led one to expect mildew about June 29, but as this was a very rainy period no observations were made. Heavy infections resulting from rains in the last days of June were reported from July 6 to 8. Observations were again interrupted by rains, but heavy infections were again reported on July 13 and heavier ones three and four days later. On the last two days mentioned the spots appeared extraordinarily healthy. New spots were not only numerous but the production of spores on all spots was heavy.

Some new infections of mildew might have been expected about the tenth of August, or soon after this, but there was an interruption in observations from the eighth to tenth and rains on the tenth and eleventh and beginning again on the fourteenth caused a further interruption. Some indications of such an infection were noted on the thirteenth in limited observations. More decided increases in mildew began to appear about August 20. Following this, increasing amounts of mildew could be found on hops till picking time and thereafter on the plants in the new yards till the middle of September.

No rainfall record was made at Waterville in 1914. The rainfall as shown on the chart is the average for the five Weather Bureau Stations nearest Waterville. For the most part rains occurred at these different places at the same time so that the dates of the general rainy periods at Waterville may at least be relied upon as given by the chart. From June 14 to 22 no observations were made, else the infections noted on June 23 and 24 might probably have been found sooner. Rains were frequent, as at Cooperstown, followed by correspondingly frequent mildew infections.

MILDEW INFECTION TAKES PLACE DURING RAINS.

Thus it appears that the new mildew spots begin to show about ten days after rainy periods. This, to the writer, seems to be the most important relation of the increase of mildew to weather conditions. In the effort to discover the relation of the weather to the spread and growth of the mildew, a daily record was made also of the maximum and minimum temperature and relative humidity.

It seems altogether probable that each of the other factors may have some effect on the growth of the mildew but their influence is not so apparent.

The field observations reported above seem to indicate that the spores of the mildew, like the spores of many other fungi, germinate and begin to grow during wet weather. The length of time between these wet periods and the appearance of new mildew spots corresponds well with that between the sowing of spores and the appearance of mildew in artificial infections.

This seems to be in accord with many of the statements previously referred to, namely, that the worst epidemics have occurred in wet seasons. At the same time, in comparatively dry seasons a few rains at critical times could easily account for heavy losses. The writer has frequently seen yards in which it was very difficult to find mildewed spots on the leaves, yet a heavy infection of the flowers or young hops nearly or quite ruined the crop.

The importance of a knowledge of this relation between rain and mildew infection seems to be that it affords the hop-grower a guide as to when he may expect new attacks of mildew on his hops. It should, therefore, be of assistance in its control. Clearly, it becomes important to sulphur after each rain unless the hops were well covered with sulphur before the rain and the rain not heavy enough to remove it.

OTHER CONDITIONS AFFECTING GROWTH OF MILDEW.

That there are other influences which affect the growth of the mildew is very apparent. Yards near enough together to be equally affected by periods of wet weather frequently show great differences in severity of mildew attacks though new spots may appear in both at the same time. Different varieties and even different leaves on the same plant vary in susceptibility. Named in order of susceptibility beginning with the most susceptible, the New York varieties would be arranged as follows: Canada red vine, English cluster, Humphrey and native red vine. No serious injury has been noticed, so far, on the native red vine variety though planted near badly infested yards and, in some instances, scattered through yards of a susceptible variety. It is said to be a light yielder, however.

On individual vines the younger leaves or other growing parts are most susceptible to the mildew. Early in the season the mildew may be expected on any of the leaves of the plant, but after the leaves near the base have developed to their full size though still green and healthy, new infections are much rarer on them than on leaves of young arms or near the tips of the vines. The flowers and young catkins (" cones " or " burs ") are especially susceptible.

It may be said, also, that the spots seem to enlarge most rapidly, look most healthy and sporulate most abundantly at a time when conditions are such as to cause a rapid development of the host plant, i. e., in warm, moist weather. In 1914, such a period was noticed about July 16. Frequent, heavy rains between the last of June and the tenth of July were followed by five or six days of comparatively warm weather. On the sixteenth, then, the mildew spots appeared particularly healthy. The conidiophores, which in continued dry weather are few and scattered, were now numerous and producing conidia in abundance. Indeed, the spores were so abundant that they could be shaken from the leaves in clouds.

Similar conditions have also been observed earlier in the season, in places where the mildew obtained an early start. In such cases, the mildew has frequently been found completely covering young leaves, petioles and tender stems. Later in the season, when the leaves have more nearly reached their full development, the mildew is usually confined to circular spots on the leaves which frequently do not reach the size of one centimeter in diameter.

Of some interest in this connection are the observations recorded by Halsted[13] and by Anderson and Kelsey.[14] In each case it was found that the powdery mildew developed more luxuriantly on parts of plants that had been stimulated by mites to form distortions. Halsted found perithecia of Sphaerotheca abundant in the buds of hackberry which had been affected by mites. Anderson and Kelsey found the mildew and mites together on a number of plants and concluded that in every case where these forms of animal and vegetable life are so associated, there is a more vigorous development and earlier maturity of the fungus than under ordinary circumstances. This seems to be in accord with what has previously been said about the growth of the fungus on the younger and more tender parts of vines. During the summer of 1914, it happened that a woodchuck ate off the vines in one corner of a yard after they were well started up the poles, with the result that these vines started many new shoots which were more tender and less mature than the vines in the other parts of the yard. The further result was that these vines were soon covered with mildew though treated in the same way as the rest of the yard which was but slightly affected.

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[13] Halsted, B. D. Notes on *Sphaerotheca Phytoptophila*, Kell. and Swingle. *Jour. Mycol.* 5:85-86. 1889.

[14] Anderson, F. W., and Kelsey, F. D. Erysipheæ upon Phytoptus distortions. *Jour. Mycol.* 5:209-210. 1889.

On the other hand, it has been observed several times in abandoned yards where mildew has attacked the plants particularly early and been allowed to go uncontrolled, that as the growth of the hops became checked because of lack of cultivation and the presence of grass and weeds, the mildew spots, also, stopped spreading on the leaves and the mildew no longer looked healthy.

Thus it appears that there are some factors in the condition of the hop plant which greatly affect the rate of development of mildew. Favorable conditions seem to be found principally in the younger growing parts of plants but in what these conditions consist has not been determined.

USE OF SULPHUR IN THE CONTROL OF MILDEW.

HISTORICAL.

Sulphur has long been used for the control of various powdery mildews, more particularly those of the grape and hop. Stevens and Hall[15] attribute the discovery of the use of sulphur for this purpose to Robinson in 1821 who is quoted as stating, "Sulphur is the only specific remedy that can be named for the treatment of mildew on peaches. It should be mixed with soapsuds and then applied by dashing it violently against the trees by means of a rose syringe." It did not come into general use until after 1850 or until the powdery mildew became a scourge to the grape vines of Europe. It was apparently then rediscovered by Tucker[16] who is quoted as having first used a mixture of sulphur and lime for the control of this disease in 1845. Reference to its use is made by a number of authors beginning with von Mohl[17] in 1852, Mares[18] in 1855 and others. The powdery mildew of grapes which did its maximum damage in France in 1854 was so speedily controlled that normal production was reached again in 1859.

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[15] Stevens, F. H., and Hall, J. G. Diseases of economic plants. p. 7. 1910.

[16] Tucker, E. Letter of E. Tucker to Gaschet. Documents pour servir à l'étude de la Maladie de la Vigne. pp. 12-14. Pub. by the Linnéenne society of Bordeaux. 1853.

It seems that comparatively little is known about the early use of sulphur on hops. Apparently its use on hops followed its successful use in the control of grape mildew, though the mildew had been present on the hop in England about a century and a half earlier than on the grape. An article, probably by Berkeley,[19] in 1869 seems to assume that sulphur would be as effective against the mildew on the hop as on the grape. Whitehead[20] wrote that sulphur had been of great use to the hop growers for the 25 years previous. At the time of his writing the practice of sulphuring hops was well established.

Mixtures of flowers of sulphur and lime were early recommended but seem to have been used comparatively little, though such recommendations may be found in the recent as well as in the older literature.[21]

Flowers of sulphur was first used because it was the only kind of fine sulphur then manufactured, but, later, the grinding of sulphur was much perfected and flour sulphur to a considerable extent has replaced the flowers of sulphur in some countries of Europe.

In the meantime, the question of how sulphur acts has been attacked and various theories have been made the basis of recommendations. It is not the writer's purpose in this bulletin to review all of the work or opinions on this subject. The earlier work has been reviewed by Sestini and Mori,[22] Windisch [23] and other writers.

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[17] Mohl, Hugo von. Die Traubenkrankheit. *Bot. Ztg.* 10:9–15. 1852.

[18] Mares, M. Sur la maniere dont la fleur de soufre agit contre le maladie de la vigne. *Compt. Rend. Acad. Sci.* (Paris) 2:41:397–399. 1855.

[19] B[erkeley], M. J. Hop. In a Cyclopedia of agriculture, by Morton. 2: 66–67. 1869.

[20] Whitehead, Chas. Hops. pp. 55–58. 1881.

[21] Tucker, E. 1853 l. c.
Ward, H. M. Diseases of plants. p. 161. 1901.
Galloway, B. T. Powdery mildew of the bean. *Jour. Mycol.* 5:214. 1889.
Duggar, B. M. Fungous diseases of plants. p. 90. 1909.
Lodeman, E. G. The Spraying of plants. pp. 174–176, 307. 1906.

[22] Sestini, F., and Mori, A. In qual modo opera lo zolfo sull'oidio della viti. *Staz. Sper. Agr. Ital.* 19:257–278. 1890.

[23] Windisch, Karl. Ueber die Wirkungsweise, Untersuchung und Beschaffenheit des zur Bekämpfung des Oidiums dienenden Schwefels. *Landw. Jahrb.* 30:447–495. 1901.

It has been shown, principally by Moritz,[24] Basarow,[25] Mach and Portele[26] and Sestini and Mori,[27] that there is a certain amount of sulphurous acid formed in a sulphured vineyard and it has been quite generally accepted that this is an active agent in killing the mildew. Sestini and Mori also showed that the sulphurous acid formed is changed, in part at least, into sulphuric acid. Pollacci[28] has shown some of the conditions under which the oxidation of sulfur takes place and agrees that the end product is sulphuric acid.

In this connection should also be mentioned the work of Kramer[29] who performed an experiment in which sulphur was heated to a moderate temperature as in the use of this material in the greenhouse, and found that the principal product was sulphuric acid. He believed that the efficiency of sulphur as used in the greenhouse is due to this acid and he found that dilute solutions of sulphuric acid are capable of killing the mildew. Marcille[30] has gone even farther and claims, on the basis of a few inadequate experiments, that the effectiveness of sulphur as used in dusting grapes out of doors is due to the sulphuric acid which it contains. He seems to believe that most of this is developed in the process of manufacture and very slowly afterward. On this basis he suggests that only flowers of sulphur should be used and that this should be manufactured to contain more sulphuric acid or that some less expensive carrier should be found for the acid.

That there is a certain amount of sulphur vapor formed from sulphur at ordinary temperatures is well known and that this may have some effect on fungus parasites has been recognized by many writers.

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[24] Moritz, J. Ueber die Wirkungsweise des Schwefelns als Mittel gegen den Traubenpilz (Oidium Tuckeri). *Landw. Vers. Stat.* 25:1–4. 1880.

[25] Basarow, A. *Weinlaube* 14:529. 1882. Cited in *Landw. Jahrb.* 30:451. 1901.

[26] Mach, E., and Portele, K. Zur Frage ueber die Art und Weise, in welcher der zur Bekämpfung des Oidiums angewendete Schwefel wirkt. *Weinlaube* 16:433, 265. 1884.

[27] Sestini, F. and Mori, A. l. c. 1890.

[28] Pollacci, E. Ossidazione spontaneae del solfo e dei solfuri mettalloidici e metallici. *Monit. Sci.* 4:32:372–375. 1908. Same. *Atti. Cong. Chim.* (Roma) 1:482–488. 1907.

[29] Kramer, H. Dilute sulphuric acid as a fungicide. *Proc. Amer. Phil. Soc.* 45:157–163. 1906.

[30] Marcille, R. Sur le mode d'action du soufre utilsés pour combattre l'oidium *Compt. Rend. Acad. Sci.* (Paris). 152:780–783. 1911.

Mach and Portele not only considered how sulphur acts but which kind is most effective. They tried to solve this problem by determining the amount of sulphurous acid formed with different kinds of sulphur under the same conditions. They found in a limited number of experiments that a larger amount of sulphurous acid was formed from the finer material. They also found that the amount of sulphurous acid increased with an increase of temperature. The numerous published recommendations, which for the most part favor the use of flour sulphur, seem to be based in part on these experiments, but very largely, also, on other considerations, as follows:

(1) Flowers of sulphur has been largely replaced by ground sulphur in use in the vineyards of Europe. At first flowers of sulphur was exclusively used for the reason that ground or flour sulphur was not then made. Since ground sulphur as fine or finer than flowers of sulphur has been on the market, it has grown in popularity with the vineyardists until it has superseded the flowers of sulphur to a considerable extent.

(2) Ground sulphur may be made finer than flowers of sulphur if sufficient care is used in the grinding. The finer sulphur should be more active because the rate of oxidation and of vaporization depends in part on the area of surface exposed. This would be larger per unit weight for the smaller particles, and for the irregular particles of flour sulphur as compared with the spherical particles of flowers of sulphur of the same size. The small quantities of sulphurous and sulphuric acids always contained in flowers of sulphur should be rapidly balanced in favor of the finely ground sulphur by the more rapid oxidation of the latter. Fine sulphur may also be spread more evenly and widely.

(3) The particles of flowers of sulphur, being spherical or nearly so, will not cling as tenaciously to vine parts as do the irregular, sharp-cornered particles of the flour sulphur.

(4) The process of manufacture of flour sulphur is such that a uniform product is readily obtained. The process is one of grinding which may be continued until the desired fineness is secured. To obtain a uniform quality of flowers of sulphur involves maintaining a large building used for a condensing chamber at a uniform temperature under the varying weather conditions throughout the year.

If the temperature is too high the particles fuse, thus altering the fineness of the product.

Further statements in literature seem to deal principally with observations or preferences. No data from field tests of different kinds of sulphur are available. Guillon[31] states that he undertook such tests but found them impracticable.

There still persists, however, in many general treatises, the statement that flowers of sulphur[32] may be used for the control of certain mildews; also, recommendations for the use of a mixture of lime and sulphur. In many cases no reference is made to any other kind of sulphur, to present practice in vine-growing countries or to recommendations of specialists in mildew control.

From what has been said, it is seen that there exist a considerable variety of recommendations which are rather puzzling when one is first confronted with them. Many recommendations found seem to be quite indifferent as to the kind of sulphur but consider more important the purity and the fineness as determined by the Chancel test.

FIELD EXPERIMENTS COMPARING DIFFERENT KINDS OF SULPHUR.

GENERAL PLAN.

When, quite suddenly, the mildew became a serious menace to the hop crop of New York State and it became desirable to know if sulphuring is a satisfactory means of control under the climatic conditions existing here, it was decided to try out flowers of sulphur, fine flour sulphur and heavy flour sulphur and a mixture of lime and sulphur under field conditions with the hope of finding out, if possible, which is the most effective and of how much importance, approximately, are the differences in fineness.

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[31] Guillon, J. M. Soufres et bouillies cupriques. *Rev. Vit.* 19:651–655. 1903.

[32] Recommend the use of flowers of sulphur:
Mohl, Hugo von. Die Traubenkrankheit. *Bot. Ztg.* 10:9–15. 1852.
Koeth, Dael v. Ueber Traubenkrankheit. *Ann. d. Oenologie* 2:118–121. 1872.
Whitehead, Chas. Chap. 13. Hops. pp. 55–58. 1881.
Galloway, B. T. Powdery mildew of the bean. *Jour. Mycol.* 5:214. 1889.
Dufour, J. L'oidium. *Chron. Agr. Vaud.* 8:229–234. 1895.
Tubeuf, Karl von. Diseases of plants. pp. 170–171, 172, 177. 1897.
Masee, George. A text-book of plant diseases caused by cryptogamic parasites. pp. 95–97. 1899.
Salmon, E. S. Monograph of Erysiphaceae. *Mem. Torrey Bot. Club* 9:60. 1900.
Duggar, B. M. Fungous diseases of plants. p. 90. 1909.
Stevens, F. L., and Hall, J. G. Diseases of economic plants. p. 20. 1910.

For this work a very good grade of flowers of sulphur was secured. This kind of sulphur is ordinarily packed in 155-pound barrels and is a bright, golden yellow in color. Flowers of sulphur is sometimes in poor mechanical condition. The cause of this will be discussed on page 279. Such sulphur does not feed through machines well. The flowers of sulphur used in these experiments, so far as could be judged from general condition and taste, never contained a considerable amount of acid and was in excellent mechanical condition.

The heavy flour sulphur or ground sulphur was the ordinary grade of refined flour sulphur packed in 250-pound barrels. In color it was a bright yellow but not as bright in color as flowers of sulphur. It was of such a fineness that about 75 per ct. would pass a 200-mesh sieve.

The fine flour sulphur or ground sulphur used was packed in 175-pound barrels. In color it was a whitish yellow. To the touch this sulphur was very smooth and floury with no noticeable roughness such as may be noticed in the ordinary flour sulphur and flowers of sulphur. It was of such a fineness that practically all of it would pass a 200-mesh sieve.

While it may be said, in general, that the finer sulphur is ground the less can be packed in a barrel, the amount packed in a barrel is not always an indication of fineness, as the barrels may not be full. So it happens that much sulphur on the market in 175-pound barrels is coarser than that mentioned above, the barrels not being full.

With the three kinds of sulphur as above described, it was hoped that if there is any considerable difference in effectiveness between sulphur of different degrees of fineness, this could be detected and that the experiments would indicate the relative value of ground sulphur and flowers of sulphur.

Our first experiments of this kind were made in 1912 in cooperation with twelve hop growers. The results have been reported in Cornell University Agricultural Experiment Station Bulletin 328. In all cases the control was so nearly perfect that no distinction could be made between the two kinds of sulphur used — fine flour sulphur and flowers of sulphur. During the past two summers a number of other trials have been made.

The general plan of these experiments has been to select yards badly mildewed the year previous and divide them into three or four plats — one plat left untreated (usually on the windward side to avoid the drift of sulphur when treating the adjacent plats), one plat sulphured with flowers of sulphur, one with fine flour sulphur, and, in some cases, a fourth plat treated with heavy flour sulphur. The different kinds of sulphur were applied to the different plats on the same day and as nearly as possible in the same amounts. The sulphur used on each plat, at each application, was weighed and the amount recorded except in a few cases of cooperative experiments when it was impossible for the writer to be present. In such cases the record was kept in parts of barrels per application or barrels of each kind for the season. The amounts actually applied varied from the desired quantities for several reasons. The machines could be regulated only roughly. The different kinds of sulphur necessitated different adjustments of the feeding device in order to distribute the same amount of material.

The result of the different treatments was determined by two separate methods. A really satisfactory method seemed difficult to find. The total weight of the crop did not seem to be of any value as a measure of mildew control because mildewed hops, though of little value, or worthless nubs weigh nearly or quite as much as the healthy hops. Sorting the hops into grades containing those affected and those not affected by mildew would be practically an endless task on any considerable area. Four or five thousand is not a large number of hops for a single hill. During the season of 1914, the following method was employed. To get samples, a trip was made through each plat, lengthwise, near its center, and small branches were removed from each vine without distinction, if such a branch were available. This seemed to furnish a satisfactorily representative sample of the different yards and the different parts of the yards. These samples were sorted into three classes, those free from mildew, those slightly mildewed but marketable, and those so severely mildewed as to be unmarketable or valueless. The hops in each lot were counted.

Considerable reliance has also been placed on an inspection of the yard shortly before picking. Slight mildew injuries to hops are almost at once apparent in the color and appearance of the hops before picking, much more so than in hops after they have been dried. It was therefore thought proper to place confidence to some extent in the judgment of dealers and growers who visited the yards before picking, especially as it is customary to determine the quality of hops by inspection. As there is no uniform system of grading hops, or standards by which to compare any particular lot, except one part of the field with another or by a rough estimate of losses, such judgments have proven hard to record satisfactorily. It may be said that in 1913, as in 1912, it frequently happened that the control was so good on sulphured portions of the yards, that losses were quite imperceptible, while on untreated portions of the same yards the loss from mildew amounted to one-half or more of the crop. In 1914, however, with long and rather continuous rainy periods, there was little opportunity for sulphuring and at few times was the weather favorable for the action of sulphur. Under such circumstances the tests of the different kinds of sulphur were more severe. The yard was rare, indeed, that did not show enough injury from mildew to furnish a basis for judgment on the relative merits of the different kinds of sulphur. At the same time local variations in each yard played no small part in the results obtained, so that different hop-growers reached quite different conclusions in regard to the different kinds of sulphur being tested. It becomes at once apparent that a true conclusion in this case can only be based on the results of experiments in a considerable number of yards. The drift of clouds of sulphur while distributing quite excludes the possibility of dividing a hop-yard into numerous small plats to avoid this difficulty.

DETAILS OF EXPERIMENTS.

King farm, yard No. 3, 1914.— In 1913, this yard had been used for an experiment comparing a mixture of sulphur and lime with flowers of sulphur alone and it became badly mildewed. The year previous it had suffered a complete loss due to mildew. It is located near the top of Burke Hill, Index, N. Y., and is situated on the slope of the hill facing the west. It was divided so that a strip seven rows wide and twenty-seven hills long was left on the west side untreated. The adjoining plat, fifteen rows wide and forty-nine hills long was dusted with flowers of sulphur. The third plat, fifteen rows wide and forty-nine hills long, was dusted with an equal amount of fine flour sulphur.

The following table gives a record of the sulphuring of this yard:

TABLE I.—SULPHURING IN KING YARD No. 3, 1914.

DATE.	SULPHUR PER ACRE.		Date of first rain following sulphuring.
	Flowers.	Fine flour.	
	Lbs.	*Lbs.*	
June 25	60	72	June 28 and 29.
July 22	73	71	July 23.
July 28	72	61	July 28 and 29.
August 4	72	58	Aug. 10 and 11.
Average	69	65.5	

Mildew was first observed in this yard on June 24. At that date a few spots were found scattered quite evenly about the yard. The applications of sulphur to this yard were followed closely by rains with the exception of the treatment on August 4, following which there was about a week of fair weather. No significant increase in mildew was noticed until July 13 and 17. This was checked somewhat by the treatments on July 22 and 28. The sulphuring on August 4 was undoubtedly the most effective as the weather was favorable and the hops were just growing out. The weather allowed no further opportunity for sulphuring.

During one of the storms this yard was severely damaged by hail so that a light yield resulted. Scattered hills in the yard were also injured by the hop aphid, but this injury was ignored in tabulating results.

Samples were collected on August 29 and classified as above described with the following results:

TABLE II.—CONDITION OF HOPS AT PICKING TIME IN KING YARD No. 3, 1914.

PLAT.	Total number.	FREE FROM MILDEW.		SLIGHTLY MILDEWED.		VALUELESS.	
		Number.	Percentage.	Number.	Percentage.	Number.	Percentage.
Unsulphured	1,601	......	......	68	4.25	1,533	95.75
Flowers	1,259	874	69.4	275	21.84	110	8.74
Fine flour	1,119	881	78.7	217	19.4	21	1.9

From this table it is apparent that the untreated portion of this yard was a complete loss — in strong contrast to both of the other portions of the yard. The plat sulphured with fine flour sulphur was better than that treated with flowers of sulphur as also appeared very clearly by inspection of the yard.

Wedderspoon yard.— This yard was chosen because it had been severely attacked by the mildew the year previous, so that only about half of the yard was picked; also, because it was one of the first in which the mildew was discovered in the spring of 1914. The yard is located in a narrow valley formed by one of the streams emptying into the west side of Otsego Lake in a locality known as Pierstown. It is situated on the southern side of the valley on sloping land, with the lower end of the yard only a little above the level of the stream.

Mildew was reported in this yard on June 6, 1914, and the report was verified a few days later by the writer although, at that time, most of the lower leaves had been removed by trimming in the hope of checking the spread of the mildew. No serious spread of the mildew was noted in this yard until June 23.

The yard was divided into plats running up and down the hill, with an untreated plat twelve hills square in the southwest corner. The following table gives a record of the sulphuring of this yard:

TABLE III.— SULPHURING IN WEDDERSPOON YARD, 1914.

DATE.	SULPHUR PER ACRE.			Date of first rain following sulphuring.
	Flowers.	Heavy flour.	Fine flour.	
	Lbs.	*Lbs.*	*Lbs.*	
June 24	51	69	56	June 28 and 29.
July 10	45	58	56	July 10.
July 16	63	64	52	July 17.
July 25	53	53	63.5	July 28.
August 7	83	62	62	August 10.
Average	59	61	58	

It is apparent that none of these applications was very happily placed, four days being the longest period following a sulphuring before a rain. The application of July 10 was the most unfortunate as a heavy rain in the afternoon washed off much of the sulphur applied in the morning.

As stated previously, an increase of mildew was noticed in this yard on June 23. This was more abundant in the part of the yard that was to be treated with flowers of sulphur. A further increase was noted on July 16 with a very heavy production of spores. The mildew continued considerably worse, up to picking time, in one end of the plat treated with flowers of sulphur. It should be remarked that this portion of the yard was also most severely affected the year previous. The unsulphured portion was on the other side of the yard and presumably the least likely to be affected.

Samples were collected from this yard on August 26 and sorted with the following results:

TABLE IV.— CONDITION OF HOPS AT PICKING TIME IN WEDDERSPOON YARD, 1914.

PLAT.	Total number.	FREE FROM MILDEW.		SLIGHTLY MILDEWED.		VALUELESS.	
		Number.	Percentage.	Number.	Percentage.	Number.	Percentage.
Unsulphured	770	77	10.0	315	40.9	378	49.1
Flowers	1,105	899	81.4	176	15.9	30	2.7
Heavy flour	681	598	87.8	77	11.3	6	.9
Fine flour	702	626	89.2	71	10.1	5	.7

In this yard the unsulphured portion, while only a partial loss, still stood in marked contrast to the rest of the yard. There seems no doubt that had it been on the side of the yard treated with flowers of sulphur, the loss would have been total.

The table represents the observed condition of the yard very well. One end of the plat dusted with flowers of sulphur seemed equally good with the rest of the treated part of the yard, while the other end was considerably damaged.

Utter yard, Cherry Valley.— This yard was chosen because it

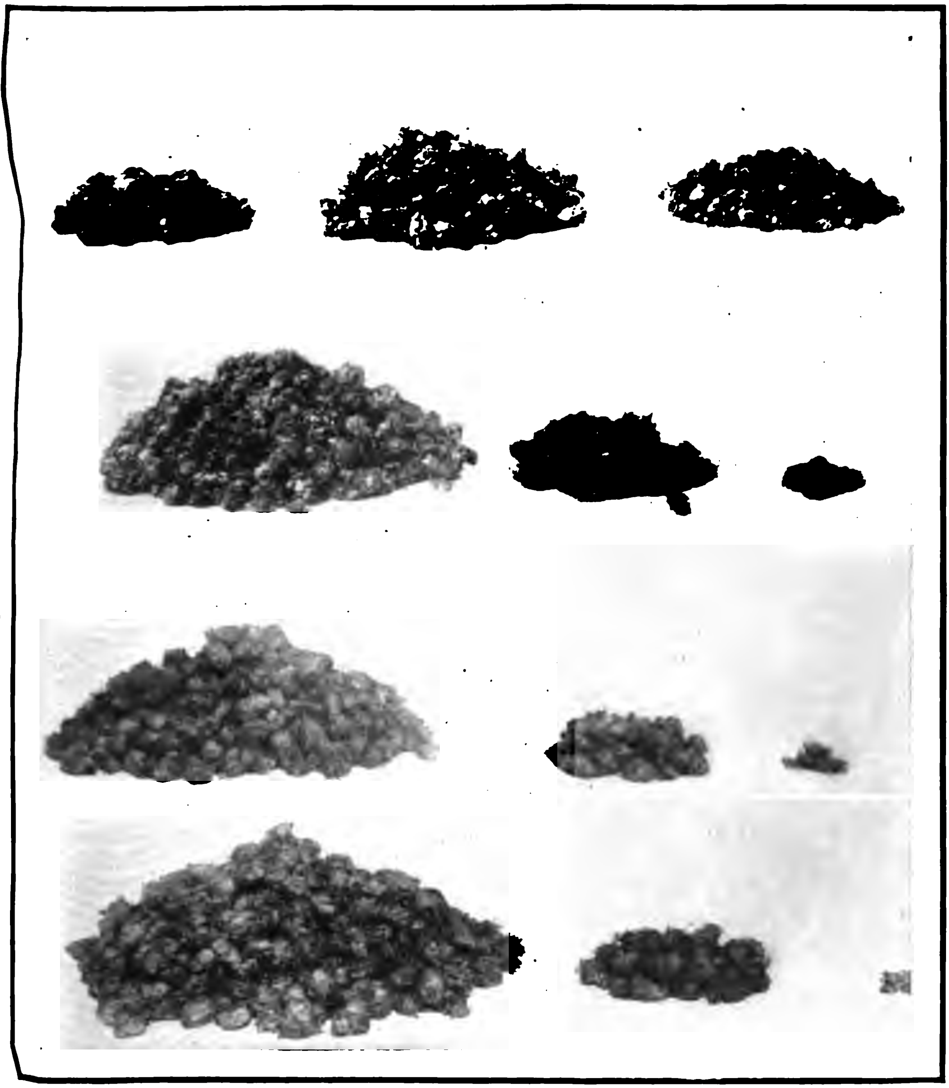

Plate XI.—Samples of Hops from Experimental Plats in Wedderspoon Yard.

Upper row, not sulphured; second row, flowers of sulphur; third row, heavy flour sulphur; bottom row, fine flour sulphur.

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had been so severely attacked by the mildew the year previous that only a small part of the yard was picked. It was also one of the first yards attacked by the mildew in that section in the spring of 1914. The yard is located at a medium elevation and is nearly level, except at the eastern end, where one side runs up the side of a small knoll. In 1913, this end was more severely affected by mildew and in it the mildew was first found in 1914.

The yard, which was 88 rows long, was divided into plats running crosswise. These plats were about 30 hills square or contained about an acre each. This manner of division of the yard was found necessary because the spaces between the rows running lengthwise on one side were so narrow that the dusting machine could not be used in them. The plat at the western end was dusted with heavy flour sulphur, the plat in the middle with fine flour sulphur and the plat at the other end with flowers of sulphur. A check plat twelve hills square was located in the southwest corner of the yard. In this end of the yard containing the check and the part dusted with heavy flour sulphur the mildew was least abundant the year previous.

In 1914 mildew was found in this yard on June 19. An increase of mildew was noted on July 6. It is likely that these spots might have been seen several days earlier had observations been made. The shipment of sulphur was delayed and rains further deferred the application of sulphur until July 13. By this time considerable increase in the mildew had taken place, particularly in the eastern end of the yard. The following table gives a record of the sulphurings in this yard:

Table V.—Sulphuring in Utter Yard, 1914.

Date.	Sulphur per acre.		
	Heavy flour.	Fine flour.	Flowers.
	Lbs.	*Lbs.*	*Lbs.*
July 13	55	54	54
July 25	80	49	77
July 31	66	51	60
August 13	75	47	87
August 25	....	....	....
Average	69	48	69.5

The weather record at Cooperstown applies only approximately to the conditions in this yard. It is known that rains were quite as frequent here as elsewhere and that the treatments on July 25 and 31 were followed shortly by rains. That on August 13 fell within the period when showers were of daily occurrence. An application of sulphur was made by Mr. Utter on August 25 as nearly like the others as possible. This was done because Mr. Utter wished to delay picking for some time. It was thought to have had very little effect on the results recorded as it was followed almost immediately by heavy rains.

The machine used in this case was not entirely satisfactory as it proved to be very difficult to regulate. With the fine flour sulphur it was always wide open. From the table it may be seen that the amount of fine flour sulphur used averaged 20 pounds less per application than for either of the other kinds.

Samples from each of the different plats of this yard were collected on September 2 and examined as usual with the results shown in the following table:

Table VI.— Condition of Hops at Picking Time in Utter Yard, 1914.

PLAT.	Total number.	FREE FROM MILDEW.		SLIGHTLY MILDEWED.		VALUELESS.	
		Number.	Percentage.	Number.	Percentage.	Number.	Percentage.
Unsulphured	1,567	62	3.9	587	37.5	918	58.6
Flowers	1,197	549	45.8	459	38.4	189	15.8
Heavy flour	1,300	1,154	88.8	110	8.4	36	2.8
Fine flour	1,547	1,158	74.9	217	14.0	172	11.1

From the table it is apparent that the untreated plat sustained a much heavier loss than any other portion of the yard. It must be remembered in this connection that the end of the yard occupied by the unsulphured plat and the plat treated with heavy sulphur, was the part of the yard where little mildew could be found at the time of the first treatment. At that time the lower leaves of many hills in the other end of the yard were white with mildew. In fact, until hops were in full bloom, mildew could scarcely be found in the unsulphured portion of the yard and at no time was it serious on the leaves there. It was only when the hops began to come out of blossom that the mildew began to develop rapidly in this portion of the yard, shortly outstripping the other portions of the yard.

There seems no doubt that if an untreated portion had been left in the other end of the yard the loss in it would have been total. The writer is of the opinion that the results as given in the table show a prejudice against flowers of sulphur not altogether deserved though representing the conditions at picking time very well.

Wilsey yard, Middlefield.— This yard was considered desirable for experimental purposes because for several years it had been a complete loss due to mildew and scattered spots of mildew were found throughout the yard on June 18 in the season of 1914.

This yard was located on a tableland near the summit of the hills of Middlefield in Otsego County. It was very nearly level and seemed as uniform as could be desired. The yard, which was 88 hills long and 41 hills wide, was divided into plats running crosswise with an unsulphured portion 12 hills square in the northeast corner. The three other plats of the experiment were 23 hills wide leaving a strip 19 hills wide to be sulphured by Mr. Wilsey. Beginning at the north end of the yard, the three plats were treated respectively with heavy flour sulphur, fine flour sulphur, and flowers of sulphur.

Applications of sulphur were made to this yard as follows:

TABLE VII.— SULPHURING IN WILSEY YARD, 1914.

DATE.	SULPHUR PER ACRE.		
	Heavy flour.	Fine flour.	Flowers.
	Lbs.	*Lbs.*	*Lbs.*
July 3	50	41.5	42.5
July 13	50	42.5	42.5
July 25	50	42.5	42.5
August 3	50	42.5	42.5
August 13	50	42.5	42.5
Average	50	42.3	42.5

At the time of the first treatment some increase in the amount of mildew had taken place. It still seemed to be quite uniformly distributed between the different plats. On July 13, fresh mildew was appearing. The yard was much improved on July 22. The last treatment was made after the rainy weather had begun in mid-August. Slight increases in mold continued to take place in August. On August 13, the section of the yard dusted with fine flour sulphur was clearly in much better condition than any of the other plats. Scarcely any injured hops could be found in this section of the yard, which formed a marked contrast to the plats on both sides of it.

Samples were secured from this yard on August 25. Unfortunately the writer had not been informed that the picking was to start so soon, so that the larger part of the plat dusted with flowers of sulphur had been picked before his arrival. A sample was secured from the remainder of the plat. The figures given, therefore, are not as reliable an index to the condition of this plat as are the figures for the other plats. Previous inspection indicated that this plat was most severely injured by the mildew of any of the sulphured plats, though probably not as much worse than the heavy flour plat as indicated by the table. The following table summarizes the results:

TABLE VIII.—CONDITION OF THE HOPS IN THE WILSEY YARD AT PICKING TIME, 1914.

PLAT.	Total number.	FREE FROM MILDEW		SLIGHTLY MILDEWED.		VALUELESS.	
		Number.	Percentage.	Number.	Percentage.	Number.	Percentage.
Unsulphured.....	1,093	12	1.1	227	20.8	854	78.1
Flowers.........	644	271	42.08	305	47.36	68	10.57
Heavy flour.....	533	367	68.9	141	26.4	25	4.7
Fine flour.......	487	458	94.04	27	5.55	2	.41

It is apparent that the unsulphured portion of the yard in this case was so nearly a total loss as not to be worth picking, about 80 per ct. being worthless and only 1 per ct. free from mildew. This was markedly different, as usual, from any of the sulphured plats. The fine flour plat was between the other two plats in this case and formed, as shown by the table, a striking contrast to the sulphured plats on either side.

Lehman yard, Sharon Springs.— This yard was located near Sharon Springs on rolling land. The year previous sulphuring operations had not been successful. The crop was a complete failure. It was the intention of the writer to supervise the sulphuring here personally but this proved impossible because the numerous rains made repeated sulphurings necessary in other yards and hindered travel. Several visits were made to this yard during the summer.

A check plat ten hills square was left unsulphured in one corner of the yard. The other plats were each ten rows wide and ninety-five hills long. As this yard was at a considerable distance from Cooperstown where the weather record was made, Mr. Lehman kept his own record of the dates on which rains occurred, together with the dates on which sulphur was applied. This record is shown in the following table:

TABLE IX.— RECORD OF RAINFALL AND SULPHURING IN LEHMAN YARD, 1914.

Dates of sulphuring.	Dates of rains.	Remarks.
	June 7.	
June 15.		
June 29	July 1	Heavy rain.
July 4	July 5 and 7	Rain.
July 8	July 9	Very heavy rain.
	July 11	Heavy rain.
July 13.		
July 20	July 23	Rain.
July 25	July 29	Rain and hail.
July 31	August 1	Rain.
August 3.		
August 8	August 10	Rain.
	August 12	Rain.
August 15	August 14	Rain nearly all week.
August 22	August 20	Rain nearly all week.
	August 24	Rain.

From this table it is apparent that several of the twelve sulphurings made were followed almost immediately by rain. The only treatments not followed by rain on the first or second day after the application were those made on July 13 and 25 and on August 3. These are probably the applications on which the control principally depended. A light application made about June 15 and one on June 29 were made with flowers of sulphur uniformly to the entire field. That on June 29 was followed by a heavy rain so probably need not be considered. The three different kinds of sulphur were used first on July 4. An estimate, based on the amounts used out of the barrels on July 14, indicated that, in the first three applications, about 125 pounds of fine flour sulphur had been used, about 130 pounds of heavy flour sulphur, and flowers of sulphur 100 pounds. At the end of the season approximately the following amounts had been used:

TABLE X — SULPHURING IN LEHMAN YARD, 1914.

PLAT.	SULPHUR PER PLAT.	
	Total.	Per application.
	Lbs.	*Lbs.*
Unsulphured	0	0
Heavy flour sulphur	300	30
Flowers of sulphur	360	36
Fine flour sulphur*	400	40

* Fifty pounds of flowers of sulphur was used on this plat for the last application.

In this yard mildew was very plentiful on June 14 and fairly well distributed, though somewhat worse in the part treated with heavy flour sulphur. On July 14, much of the mildew still appeared healthy. By August 1, however, a great improvement in the condition of the yard was noticed. At this time some sulphur was noticed on the leaves in the check plat where it had drifted with the wind. On August 25, it was apparent that very little loss would occur in any plat except the unsulphured one. Samples were collected in this yard on September 4 and an examination of the hops gave the following results:

TABLE XI — CONDITION OF HOPS IN LEHMAN YARD AT PICKING TIME, 1914.

PLAT.	Total number.	FREE FROM MILDEW.		SLIGHTLY MILDEWED.		VALUELESS.	
		Number.	Percentage.	Number.	Percentage.	Number.	Percentage.
Unsulphured	933	78	8.3	317	34.0	538	57.7
Flowers	786	658	83.75	72	9.15	56	7.1
Heavy flour	1,004	744	74.1	134	13.35	126	12.55
Fine flour	912	747	81.9	92	10.1	73	8.0

The plat left untreated was not so badly mildewed in this case as in some of the other yards, probably because the wind happened to be right to blow the sulphur into it several times when the rest of the yard was being treated. Still, it presents a strong contrast to the rest of the yard. When observations were made on August 25 and September 4, Mr. Lehman and the writer agreed that the plat dusted with fine flour sulphur was in slightly better condition than either of the other treated plats. The writer believes it was better, but that by chance one of the samples used in the preparation of the table was not exactly representative. The difference between the two plats was not great, however, and the results as shown in the table correspond otherwise very well with field observations.

Russel yard, Milford.— This yard was considered desirable for experimental use because it consisted almost entirely of Canada red vines which is one of the varieties most susceptible to attack by the mildew. This yard has been under observation for several years. In 1911, it was a total loss from mildew. In 1912, the mildew had a good start in the yard on June 10. During that year the hop-growers of Milford formed an association with Mr. C. L. Slocum in charge to advise in control work. The fight with the mildew proved strenuous throughout the summer but ended with very little loss. The quantity of sulphur used was about three hundred pounds per acre. During the following season the conditions and results were much the same. The yard was utilized in a test of two kinds of sulphur. A plat ten hills square was left untreated. Although some sulphur drifted into this plat the loss from mildew was fully 50 per ct.

The yard is situated just outside the village of Milford. It lies on the side hill on the west side of the valley. In 1914 it was divided into three main plats with a fourth plat ten hills square in the southwest corner left untreated for a check. The first ten rows on the west side were dusted with flowers of sulphur, the next ten rows with heavy flour sulphur and the last fourteen rows on the east side with fine flour sulphur.

In an examination of this yard on June 18 no mildew was found, although one mildewed hill had been found in an adjacent yard. On making another examination on June 24, a few young mildew spots were found throughout the yard, but more numerous on the east side. A fresh crop of mildew was also found in this yard on

July 13. On July 24, the yard did not seem to have improved much as fresh mildew was still appearing to a limited extent. On August 6 the mildew seemed to be pretty thoroughly checked except in the unsulphured part of the yard where it was attacking the young hops.

The writer was present when part of the treatments were made in this yard. The others were made by Mr. Russel, alone, with his machine adjusted as nearly as possible in the same manner. The amounts of sulphur used at each application made when the writer was present will be given and the total amount of each kind used for the season. The following table gives this record:

TABLE XII — SULPHURING OF RUSSEL YARD IN 1914.

DATE.	SULPHUR PER ACRE.		
	Flowers.	Heavy flour.	Fine flour.
	Lbs.	*Lbs.*	*Lbs.*
June 27	40	30	30
July 3	....	....	....
July 15	47	52	39
July 25	....	....	....
Aug. 6	50	71	43
Aug. 13	....	....	....
Total	304	322	237
Average	51	54	39.5

As in several other cases, some sulphur was blown into the part of the yard that was intended to be left untreated. In this case the corner of the yard that seemed the most desirable place for the check plat from the standpoint of the usual direction of the wind, could not be used because woodchucks had eaten many of the vines early in the season and the new growth of vines which came up later was thought to be more susceptible to the mildew. Little mildew was seen in the untreated portion until the middle of July. However, as usual, it rapidly increased after the young hops began to form.

Samples were collected from this yard on August 27. An examination of these hops gave the results shown in the following table:

TABLE XIII — CONDITION OF HOPS AT PICKING TIME IN RUSSEL YARD, 1914.

PLAT.	Total number.	FREE FROM MILDEW.		SLIGHTLY MILDEWED.		VALUELESS.	
		Number.	Percentage.	Number.	Percentage.	Number.	Percentage.
Unsulphured.....	856	52	6.08	561	65.5	243	28.4
Flowers..........	987	848	85.9	118	12.0	21	2.1
Heavy flour......	1,070	978	91.4	79	7.4	13	1.2
Fine flour.......	1,152	900	78.1	224	19.4	28	2.4

The unsulphured portion of the yard was not as badly mildewed as had been the case in some instances, but still presented a strong contrast to the rest of the yard. In such a yard as this, there can be little doubt that the loss would have been complete had no sulphuring been done. The check, as it was, however, presents a sufficiently strong contrast to the rest of the yard for our purposes. Between the other plats little difference could be seen by inspection. Early in the season, as previously mentioned, more mildew was present in the fine sulphur part. This was checked, however, and at picking time little mildew could be seen in any of the dusted plats. It will be noticed that the percentage of badly mildewed hops as recorded in the table varies only about one per ct. between the different samples, which is only such a variation as might be expected between two samples from the same plat. The percentage of slightly mildewed hops is against the fine flour sulphur by a small amount. No very important difference in the sulphured plats can be claimed, however. In a measure, the conditions in this yard may be considered the reverse of the conditions in the Wedderspoon and Utter yards where the mildew was thickest early in the season in the parts dusted with flowers of sulphur; but in this case it was more strongly checked.

SUMMARY OF RESULTS IN SIX YARDS.

The results of control experiments with different kinds of sulphur are brought together into one table in order that the results of the different experiments may be more readily compared and summarized. The total amounts of sulphur applied to the different plats and the number of applications for the different yards are summarized in the following table:

TABLE XIV.—SUMMARY OF SULPHUR APPLICATIONS IN PRECEDING EXPERIMENTS.

YARDS.	Number of applications.	SULPHUR PER ACRE.					
		FLOWERS.		HEAVY FLOUR.		FINE FLOUR.	
		Total.	Per application.	Total.	Per application.	Total.	Per application.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Lehman	11	360	33	300	27	400	36
King No. 3	4	277	69	......	......	262	65.5
Russel	6	304	51	322	54	237	39.5
Wilsey	5	212.5	42.5	250	50	212.5	42.5
Utter	4	278	69.5	276	69	191	48
Wedderspoon	5	295	59	306	61	289.5	58
Average	......	287.7	54	291	52	265.3	48

It is apparent from the table that, while the intention was to apply the same amount of sulphur to all plats and usually about fifty pounds per application, considerable variation from this schedule occurred due to difficulty in regulating the machines. The average amounts per application are nearly the same. There was in some cases a difficulty in getting machines to apply as much of the fine flour sulphur as was applied of the coarse flour and the flowers. This should perhaps be borne in mind in considering results: i. e., if there was any advantage in amounts of sulphur used it was against the fine flour sulphur.

The following table gives a summary of the results on the yards included in the above table:

Table XV — Summary of Results of Six Experiments with Different Kinds of Sulphur for the Control of Hop Mildew.

Yards.	Total number hops.	Free from mildew.		Slightly mildewed.		Valueless.	
		Number.	Percentage.	Number.	Percentage.	Number.	Percentage.
Unsulphured plats.							
Lehman	933	78	8.3	317	34.0	538	57.7
King No. 3	1,601	0	0.0	68	4.25	1,533	95.75
Russel	856	52	6.08	561	65.5	243	28.4
Wilsey	1,093	12	1.1	227	20.8	854	78.1
Utter	1,567	62	3.9	587	37.5	918	58.6
Wedderspoon	770	77	10.0	315	40.9	378	39.1
Average	......	......	4.9	......	33.8	......	61.3
Probable error	......	......	±1.0	......	±5.0	......	±5.8
Sulphured with flowers of sulphur.							
Lehman	786	658	83.75	72	9.15	56	7.1
King No. 3	1,259	874	69.4	275	21.84	110	8.74
Russel	987	848	85.9	118	12.0	21	2.1
Wilsey	644	271	42.08	305	47.36	68	10.57
Utter	1,197	549	45.8	459	38.4	189	15.8
Wedderspoon	1,105	899	81.4	176	15.9	30	2.7
Average	......	......	68.06	......	24.11	......	7.83
Probable error	......	......	±4.9	......	±3.9	......	±1.3
Sulphured with heavy flour sulphur.							
Lehman	1,004	744	74.1	134	13.35	126	12.55
Russel	1,070	978	91.4	79	7.4	13	1.2
Wilsey	533	367	68.9	141	26.4	25	4.7
Utter	1,300	1,154	88.8	110	8.4	36	2.8
Wedderspoon	681	598	87.8	77	11.3	6	0.9
Average	......	......	82.2	......	13.37	......	4.43
Probable error	......	......	±2.8	......	±2.0	......	±1.3
Sulphured with fine flour sulphur.							
Lehman	912	747	81.9	92	10.1	73	8.0
King No. 3	1,119	881	78.7	217	19.4	21	1.9
Russel	1,152	900	78.13	224	19.44	28	2.43
Wilsey	487	458	94.04	27	5.55	2	.41
Utter	1,547	1,158	74.9	217	14.0	172	11.1
Wedderspoon	702	626	69.2	71	10.1	5	.7
Average	......	......	82.81	......	13.1	......	4.09
Probable error	......	......	±1.8	......	±1.4	......	±1.1

It is clear from this table that the yards used in these experiments would have been practically a complete loss if they had not been sulphured. It scarcely needs the explanation that probably in no case was the check so severely attacked as it would have been if most of the yard had not been sulphured. This, as has been previously pointed out, is because a little sulphur was blown into the check plats in nearly all cases and because in leaving a small area of this kind, frequently in a part of the yard where there was less mildew, the chance for infection was reduced.

The conditions given above should not be taken as representative of the average field, but rather of the type of field selected for this experiment. That most yards would approximate these conditions seems likely, still yards occasionally pass through the season unsulphured with little injury from mildew. On the other hand, with the exception of a few native red-vine yards, the writer knows of no instance in which an unsulphured yard has continued year after year to escape serious injury from mildew.

The experimental yards were selected, however, because they had been injured seriously by the mildew the year previous, and because some mildew was present in the spring of the current season, so that a good test of sulphuring could be expected. It is clear from the results on the check plats that where the mildew has appeared by the middle of June or earlier the loss is fairly certain to be nearly or quite total providing the normal amount of rainfall occurs.

The difference between the average results for the check plat and the average results for the plats dusted with sulphur is large enough to be decidedly significant, as is also the difference in each separate experiment. That is to say, in this, the worst year so far encountered for successful sulphuring, approximately 80 per ct. of the hops were free from mildew on the treated plats as compared with 5 per ct. on the check plats. On the sulphured plats 95 per ct. of the hops were salable. Of these 15 per ct. were slightly injured but for the most part they could not be detected in the dried sample. Though 38 per ct. of the hops on the checks are classed as salable, only 5 per ct. were free from mildew, so that the quality of these was much poorer than of those classed as salable in the case of the sulphured plats. If the whole yard had been like the check plats, they would not have been considered worth picking in most cases.

Differences between the results from the use of different kinds of sulphur are much smaller. The very slight differences between the average results of using the heavy flour sulphur and fine flour sulphur are of no significance, inasmuch as they are smaller in each case than the probable error. A comparison of the results secured in the different fields shows that the results are sometimes slightly in favor of one kind of sulphur and at other times slightly in favor of the other. It is clear then that these experiments fail to establish any difference in value between the fine and coarse flour sulphur used for dusting hops. The only indication that fine sulphur may be better is contained in the fact that in making applications of fine flour sulphur we usually failed to apply quite as much as of the coarser or heavy flour sulphur in getting these results.

In the case of the flowers of sulphur, the average results differ more markedly from the results of the use of the other two kinds. The results for the flowers of sulphur are not uniform, however, which makes the probable error high and indicates that this average is less dependable than the others. In three cases, as previously explained, the parts of the yards treated with flowers of sulphur seemed to be slightly more subject to attack of the mildew. On the other hand, in two yards the liability to mildew was rather in the other direction. In each case this was reflected in the results, but less markedly in the cases where fine and heavy flour sulphur were applied. These results indicate that the flour sulphur of the two different degrees of fineness used in these experiments is certainly as effective for preventing the mildew as the flowers of sulphur. There is also a basis for a strong presumption that the flour sulphur is a little more effective and dependable.

SUMMARY OF ALL COOPERATIVE EXPERIMENTS.

A number of other experiments have been carried out in which either two or three kinds of sulphur were tried side by side during the years 1912, 1913 and 1914. In all, there have been made twenty-seven such experiments involving about seventy-five acres of hops scattered through several counties. In twelve of these experiments unsulphured portions were left as checks. In all cases except in the six experiments already described, determination of the results was made only by inspection of the yards at picking time. In twelve cases a record was made of the amounts of sulphur applied, dates, etc. In the rest of the experiments the sulphuring was carried out by the growers, who applied the two or three kinds of sulphur to equal parts of the same yard in as nearly equal amounts as possible. The amounts applied were checked up from time to time to see that approximately the same amounts per acre were used on the different plats. The following table gives a summary of the amounts of sulphur used in the yards in which untreated plats were left:

TABLE XVI.—SUMMARY OF SULPHURING IN TWELVE EXPERIMENTS.

YARD.	Number of applications.	SULPHUR PER ACRE.					
		FLOWERS.		HEAVY FLOUR.		FINE FLOUR.	
		Total.	Per application.	Total.	Per application.	Total.	Per application.
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
King No. 1 (1913)	3	188	63	150	50	135	45
King No. 2 (1913)	4	236	59	......	......	226	56.5
Wilson (1913)....	4	218	54.5	255	64	230	57.5
Russel (1913)....	6	300	50	......	......	300	50
Bellinger (1913)..	5	250	50	200	40	250	50
King No. 2 (1914)	3	142	47	......	......	139	46
Wilsey (1914)....	5	212.5	42.5	250	50	212.5	42.5
Wedderspoon (1914)........	5	295	59	306	61	289.5	58
Lehman (1914)...	11	360	33	300	27	400	36
Utter (1914).....	4	278	69.5	276	69	191	48
King No. 3 (1914)	4	277	69	......	......	262	65.5
Russel (1914)....	6	304	51	322	54	237	39.5
Average.....	......	255	54	257	52	239	49.5

It is apparent that slight variations occurred in nearly all instances due to the difficulties in regulating the machines, the only constant variation being the tendency to apply less of the fine flour sulphur than of the other kinds.

In many cases it was found impossible to make any distinction between the control of the mildew on the plats treated with the different kinds of sulphur. That is, in 1912 and 1913, the control was frequently so good in sulphured parts of yards that scarcely any mildew could be found. With one possible exception, the twelve unsulphured plats developed serious losses ranging from 50 per ct. to a total loss. In the twenty-seven trials of flowers of sulphur and fine flour sulphur in the same yard, the flowers of sulphur plat was distinctly better in only one instance, the fine flour sulphur in seven instances. In the other yards there was no appreciable difference. Of ten times that flowers of sulphur has been compared with heavy flour sulphur, the flowers of sulphur gave better results in one instance and the heavy flour sulphur in six instances, the other trials being indeterminate. In the ten trials where fine and heavy sulphur have been compared, each has appeared better three times and the other times there was no choice. Clearly these results tend to confirm the conclusion previously stated, that heavy and fine flour sulphur are of about equal value, with flowers of sulphur taking a close third place. All have proved entirely effective in the majority of cases.

OTHER CHARACTERS OF THE DIFFERENT KINDS OF SULPHUR TO BE CONSIDERED.

In a previous bulletin[33] the writer has briefly described the different kinds of sulphur and the methods of manufacture. To this only a few notes need be added now concerning some experiences since 1912.

FLOWERS OF SULPHUR.

The flowers of sulphur has been the kind most largely used in this state for treating hops. Frequent complaints have, however, been heard that certain barrels of sulphur received will not work in the sulphuring machines. During the past season such complaints were particularly frequent. In some cases several barrels of sulphur were discarded by a single grower because they could not be used. In many other cases the growers persisted in trying to use this sulphur, but were able to apply only small amounts because it would not feed through the machines, and the little that would feed through was poorly distributed. Sometimes the resulting loss was much greater than the value of the sulphur.

The writer has often roughly examined such barrels of sulphur. The color is usually dull as compared with good flowers of sulphur which is a bright yellow. Such sulphur has a tendency to pack when pressed together in the hands not noticeable in good flowers of sulphur. When put in dusting machines, it will not feed well, tending to bridge over the outlet tube and feed very irregularly. As it leaves the delivery tube, much of it is in the form of small, flaky masses which do not float well in the air; hence, it does not distribute well. In extreme cases it drops to the ground as fast as blown out, making a yellow path along the center of the row.

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[33] Blodgett, F. M. Hop Mildew. New York Cornell Sta. Bul. 328:308–309. 1913.

A decidedly acid taste was always noticed in such sulphur, while no such taste could be detected in sulphur of good mechanical condition. In order to confirm this qualitative test, samples were taken from two lots of sulphur in the poor mechanical condition mentioned above and, also, from a barrel of sulphur in comparatively good mechanical condition. These samples have been tested for acid content by M. P. Sweeney of the Chemical Department of this Station. The acid found was sulphuric acid as follows:

TABLE XVII.—ACID CONTENT OF FLOWERS OF SULPHUR.

Sample.	Condition of sulphur.	PERCENTAGE OF SULPHURIC ACID.	
		First test.	Duplicate test.
I............	Good mechanical condition.......	0.07	0.07
II............	Poor mechanical condition........	1.96	1.96
III............	Poor mechanical condition........	1.74	1.74

It is apparent that sufficient acid was present to account for the trouble described. The presence of sulphuric acid in sulphur naturally leads to the absorption of a certain amount of moisture and thus to the aggravation of the trouble. Sifting the sulphur has been reported to make it worse, especially if done when the air is moist.

Juritz [34] has recorded trouble, which he thought was caused by the presence of moisture and the moisture in turn was condensed from the air due to the presence of a " noticeable — although very minute — quantity of sulphuric acid." Although nearly two per ct. of sulphuric acid could scarcely be considered minute, the trouble referred to above is clearly only an exaggerated form of the same condition.

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[34] Juritz, C. F. Sulphur as a pest remedy. *Agr. Jour. Cape Good Hope* 33:723–725. 1908.

No data are available as to the effectiveness of flowers of sulphur with a high acid content, but it is apparent that if it is impossible to apply it so as to get a good distribution it cannot be effective. Marcille[35] has advanced the theory that the efficiency of sulphur when used for the control of powdery mildews is due to the sulphuric acid contained, and he suggests that sulphur should be made containing larger amounts of this acid to be more effective. Clearly, this suggestion is not practicable as it is impossible to distribute satisfactorily a sulphur containing a high percentage of acid.

FLOUR SULPHUR.

A considerable amount of flour sulphur has been used in the control of hop mildew during the past two years, though not always appearing under that name. Part of this was an imported sulphur sold in bags, which was quite difficult to use because it had in many instances become packed and caked. This may have been due to the long distance that it had been transported and possibly to the moisture absorbed during an ocean voyage. At least it could not be used without a thorough sifting to break up the lumps and balls, which was difficult. As a rule this gave very poor satisfaction for the reason stated and comparatively little has been used during the past season. During the latter part of the past season no more flowers of sulphur were available on the market, so that a large part of the growers used some domestic flour sulphur at the end of the season. No complaints were heard from this sulphur in the brief time it was tried.

The fine flour sulphur used by the writer was more difficult to sift than a good quality of flowers of sulphur. It was used in both kinds of dusting machines on the market although with one of these it was not always possible to apply fifty pounds per acre even when going in every row with the feed regulating device wide open. This sulphur was, however, quite uniform in mechanical condition and could be applied much more satisfactorily than the acid sulphur above referred to. Usually some of the clots or balls of sulphur were not entirely broken up by sieving or were formed afterward, but the larger part of this sulphur formed a cloud that floated especially well in the air.

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[35] Marcille, R. Sur le mode d'action du soufre utilsés pour combattre l'oidium. *Compt. Rend. Acad. Sci.* (Paris). 152:780–783. 1911.

The heavy or coarser sulphur used showed a much less tendency to pack, was easier to sift, and more could be applied with the types of machines in use. This kind of sulphur did not feed from machines quite as freely as the best flowers of sulphur, but no trouble was experienced in applying a sufficient quantity of it. It did not have so much tendency to form lumps as the fine flour sulphur or the flowers of sulphur with high acid content.

It should, perhaps, be here pointed out that the results of sulphuring experiments reported in this bulletin do not disprove the theories previously mentioned, i. e., that the finer sulphur should be expected to be more active. Rather, it seems that this advantage to be expected from the use of finer sulphur has been balanced by the better mechanical condition of the coarser sulphur. In comparison to the attention which has been given to the determinations of the fineness of sulphur, it seems that the physical condition of the sulphur in other respects has been slighted.

It should not be understood, however, that extremely coarse sulphur is recommended or thought desirable. The sulphur appearing under the name of heavy flour sulphur in descriptions of the experiments contained a considerable percentage of fine sulphur which was probably the more effective part, while the larger particles tended to help the sulphur retain a better mechanical condition. It is quite easily demonstrated by dusting a leaf with this heavy sulphur and then subjecting it to a light shaking, examining it before and after shaking, that only the finer particles are retained on the leaves under such conditions. Undoubtedly, then, most of the coarser particles roll off from the leaves, fall to the ground and are wasted. Though these coarse particles were absent in the fine flour sulphur, a similar and sometimes greater loss occurred through the tendency of the individual particles of this sulphur to cling together forming lumps or balls which fell to the ground. It appears, then, that with the present dusting machines, a considerable amount of sulphur is wasted and that it is more economical to waste it before considerable labor has been expended in grinding it fine.

USE OF MIXTURES OF SULPHUR AND LIME.

At Waterville, in 1911, an experiment was carried out which was designed to determine the value of a mixture of sulphur and lime as compared with sulphur alone for combating this mildew. The results of this experiment were decidedly against the use of lime with sulphur for this purpose. A brief report [36] of this experiment was made in 1913.

In 1913 it was thought desirable to repeat this experiment to check up previous results. For this purpose one of the yards on the King farm at Index was used. During the year previous this yard had been a complete loss from mildew and the mildew was found present on June 18 in 1913. The yard was divided into four plats to be treated as follows beginning on the west side:

Plat I. 7 by 27 hills, to be untreated throughout the season.

Plat II. 10 by 49 hills, to be dusted with flowers of sulphur.

Plat III. 10 by 49 hills, to be dusted with an amount of flowers of sulphur equal to that used in plat II plus an equal amount of hydrated lime, i. e., twice as much of the mixture as of sulphur used in plat II.

Plat IV. 10 by 49 hills, to be dusted with an amount of sulphur and lime mixture equal to the amount of flowers of sulphur used on plat II.

These conditions were only approximated in practice as the following table will show:

TABLE XVIII.— SULPHURING IN KING YARD NO. 3, 1913.

DATE.	SULPHUR PER ACRE.		
	Plat No. 2. Flowers of sulphur.	Plat No. 3. Sulphur and lime mixture.	Plat No. 4. Sulphur and lime mixture.
	Lbs.	*Lbs.*	*Lbs.*
June 22	49	139	41
July 3	77	119	91
July 15	78	123	99
August 5	72	101	82
August 14	98	145	108
Average	75	125	84

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[36] Blodgett, F. M. Hop mildew. New York Cornell Sta. Bul. 328:298. 1913.

Of the applications made in this yard, that on August 5 was the most unfortunate, coming as it did in a critical time in the development of the hops but being followed by a heavy rain on the day following. An application on July 25 would have been more desirable.

The mildew was found in this yard on June 18 as small spots scattered pretty evenly throughout the yard and an adjoining yard. In the untreated portion of the yard the mildew increased rapidly and quite covered the leaves of most of the plants early in July, as also on scattered plants throughout the yard. In the unsulphured portion of the yard practically all of the hops failed to come out and an examination showed that the blossoms and "burs" had been infected with mildew. In the dusted portion of the yard it seemed checked at times and was at all times better than the untreated portion of the yard. The most considerable increase of mildew occurred during the last of July and first of August. Another difficulty developed in making the applications. In applying large quantities of the mixture of lime and sulphur in the center of the yard, it was found that the lime made a mixture that floated so much better in the air than the sulphur alone, that with the slight changes of the wind, it was carried through all parts of the yard in quantity. It was apparent that the strip of ten rows allowed was entirely too narrow. Thus it happened that the plat intended for sulphur alone had a considerable quantity of lime mixed with the sulphur. On the other side of the sulphur plat was the untreated plat badly infested with mildew, making the conditions very unfair for the sulphured plat.

At picking time the unsulphured plat was a total loss. There was much more difference between the two ends of the same plat than among the different dusted plats. A very large proportion of the hops on the dusted plats had been attacked by mildew during some period of their growth, and so were dwarfed or injured in some part. The yield of this yard was about half a crop, in quantity, of very poor-quality hops. The rather unsatisfactory ending of the experiment is believed to have been due principally to the influence of the lime which drifted onto the hops of the plat dusted with flowers of sulphur.

Just over a low stone fence from the yard in question was another yard (No. 4) which was dusted only with flowers of sulphur. Sulphur was applied to the two yards on the same day in each instance and at the same rate per acre. Also mildew was found in both at the same time in the spring. It is perhaps fairer to compare the sulphur and lime dusted plats with this yard than with the sulphured plat in yard No. 3 as the lime did not drift into this yard to any considerable extent. The unsulphured plat in yard No. 4 was nearly though not quite a complete loss and therefore not quite as bad as the unsulphured plat in yard No. 3. The loss on the unsulphured portion of this yard was scarcely appreciable as compared with the loss of at least half the hops in the yard dusted with sulphur and lime.

This, together with the fact that only similarly poor control of mildew has been secured in experimental plats when the sulphur and lime mixture was previously used, indicates that lime is not a proper diluent to be used with sulphur for the control of mildew. In one plat in field No. 3, over six hundred pounds of this mixture was applied per acre or over three hundred pounds of sulphur. If we may judge by the adjoining field this should certainly have been more effective. During the season of 1914, fifty pounds less of sulphur per acre without lime has proven much more effective in the same field (Table II) under the more severe conditions of the past season, the check plat being again a complete loss.

SOME STATISTICS OF CONTROL IN HOP-GROWERS' ASSOCIATIONS.

As previously described by the writer (l. c.) local cooperative associations of hop growers were organized three years ago at Milford and Waterville. An expert was secured by each association to direct their efforts toward the control of the mildew. The writer, being charged with general oversight of these operations, has sought to obtain a fairly complete record of this work. The Milford association was discontinued at the end of one year, but the Waterville association has continued for three years. In the latter association there has been represented each year about 500 acres of hops. While the membership of the association has varied from year to year, many yards have been represented continuously throughout the three years. It seems that an analysis of the extensive experience of these associations should throw some light on the practical control of mildew.

CRITICAL PERIODS.

Some reference has already been made to the dates on which new mildew infections appeared and these are shown graphically in Fig. 5. In general it may be said that small amounts of mildew were usually found in a few yards of the association between June 10 and 15 and in a few cases earlier. With very few exceptions, all yards in the associations have had at least a small amount of mildew present by July 1. Usually there has been an increase in mildew shortly after the hops begin to grow out from the flower stage, at which time they appear to be particularly susceptible to attacks of the mildew. Thus new infections have usually been particularly heavy from August 1 to 12. These dates are only approximate, as the periods of infection appear to depend more particularly on the periods of rainfall. With the infection appearing so generally in yards before the blossoming period, it is apparent that with no protective measures, infections during the blossoming period are certain to be serious in many cases.

COMMENCEMENT OF SULPHURING.

The records of the association work show that the date on which sulphuring has been begun has varied more widely than the dates on which mildew was observed to appear. In very few instances has sulphur been applied as early as June 10. In 1912, about two-thirds of the yards had been sulphured before the first of July, while most of the remainder were treated by the tenth. In 1913, the majority of the yards had been sulphured before the first of July, and most of the remainder by the fifth. In 1914, most of the yards were not dusted for the first time until after the first of July. It was particularly noticeable that nearly all of the few failures in control, occurring particularly in 1912 and 1913, were among those who delayed sulphuring though advised to make the applications. In several of the more prominent of such instances, sulphuring was delayed till the last of July or first of August. In 1914, with extremely wet weather, a larger number of losses occurred. Many of these, though not all, could be traced to poor control during the early part of the season.

AVERAGE AMOUNTS OF SULPHUR USED.

The following table presents a summary of amounts of sulphur used per acre, the number of applications and amounts per application for the Waterville association. The record is not complete for 1912 so that figures can be given for only part of the acreage of that year.

TABLE XIX.—SUMMARY OF SULPHURING IN HOP GROWERS' ASSOCIATION, WATERVILLE.

YEAR.	Acres.	Average weight per acre.	Average number applications.	Average weight per application.
		Lbs.		*Lbs.*
1912	299.5	165	5.2	31.7
1913	525	160.7	4.5	35.7
1914	476	249	5.6	44.5

It is apparent that in 1914, with the frequent rains, the amounts of sulphur applied were considerably increased and probably could have been profitably still further increased as there were at least a few more losses in 1914 than in previous years. These variations in the amount of sulphur necessary in different seasons are shown graphically in the curves in Fig. 6, which also give some idea of wide variation in the amount of sulphur found necessary in different yards for the same year. In a few instances no sulphur was used, while in others it was considered necessary to use over 400 pounds per acre. It seems apparent, then, that no exact rules can be made as to amounts of sulphur necessary to most economically control the mildew in all yards.

EXPENSE OF SULPHURING.

This summary indicates clearly that the application of sulphur has proven an economical means of controlling mildew. The average amounts of sulphur applied for the season per acre has been approximately 190 pounds. Assuming a cost of $2.75 per hundred pounds which is comparatively high, the average cost of sulphur per acre has been about $5.25. The cost of applying this has not been computed for the individual cases and would undoubtedly vary much depending on the size and shape of the field and many other factors. One man with a horse can, however, easily dust ten acres in a day. When a second man assists by sifting sulphur, thereby saving delays for the driver, a larger acreage can be treated. As the average number of applications for the season is about five, it is apparent, then, that about one-half day's work for a man and horse, or perhaps $2.00, must be charged against each acre for labor. The original cost of sulphuring machines has varied from $70 to $75. They should last for several years. The amount to be charged to each acre because of depreciation in the machine should be comparatively small, so that the total average expense of sulphuring has probably not been over $8.00 per acre. The average yield per acre for 1913 and 1914 in the association yards being 58 boxes or about 696 pounds per acre, the average expense of sulphuring per pound of hops raised was approximately $.0115. In other words, with hops at 25 cents per pound, it would be necessary to save 32 pounds per acre or less than five per ct. of the crop, to pay the expense of sulphuring. Obviously from the standpoint of expense this method of control may be considered practical.

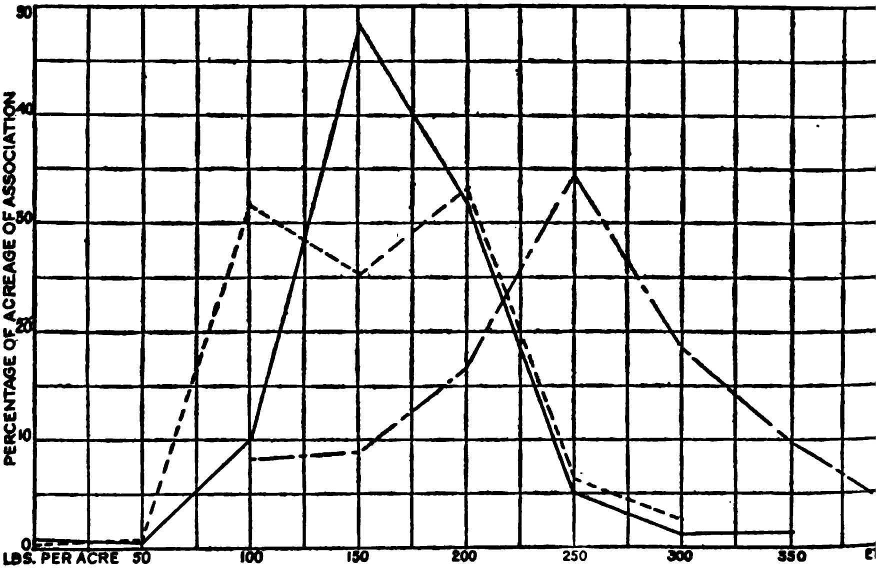

FIG. 6.—CURVES SHOWING AMOUNTS OF SULPHUR APPLIED PER ACRE IN 1912 (———) 1913 (- - - -) AND 1914 (– ——) BY THE WATERVILLE ASSOCIATION. (Average amount in 1913, 160 pounds; in 1914, 250 pounds.)

ESTIMATION OF RESULTS OF SULPHURING.

Unfortunately there is no means of determining accurately the amount of hops saved by sulphuring within these associations. Approximations may be arrived at in several ways, i. e., by comparing the losses within the association with losses before sulphuring was begun or by comparing conditions in treated districts with other places. Both of these methods present difficulties. The first method is not entirely reliable because previous to the formation of the association the mildew had not become so widely distributed as later and, also, sulphuring was begun to a limited extent before the association was formed. In 1909, the mildew did serious injury in only one yard about Waterville. In 1910 it caused complete losses in parts of three or four yards. Sulphuring was begun late in the summer of 1910 in two yards. During the summer of 1911 about 50 horse-power machines besides a number of hand machines were sold for dusting hops. A considerable part of these were sold about Waterville, so that more or less sulphuring was done in 1911. Much of this, however, was done late in the season so that only part of the loss was prevented.

During the winter following, associations were organized at Waterville and Milford and question sheets were sent out to the members asking, among other things, for estimates of the losses due to mildew the year previous. For the Waterville association, 33 of the replies are available involving a total of 354 acres of hops. Of these, six acres were new fields with no crop losses. Of the remainder, the yards on six farms, involving a total of 92 acres, had been under observation by the writer and sulphured under his direction in 1911. The losses in these yards were reported as " none " or " very slight." No statement was made concerning 34 acres. Of the remaining 24 farms, involving 222 acres, 12 were reported to have been sulphured more or less. Of these 24, three reported no losses, 5 very slight losses, the remaining 16 reported losses ranging from one-fifth to the entire crop. The losses as given total approximately 57,000 pounds of hops which at the ruling price of hops that season meant a loss of $25,000 to those 24 farms.

At the end of the season of 1912, the first year of association sulphuring, a survey was made of the results on 36 farms involving a total of 300 acres. In eleven cases losses were reported as very small, while in two cases, involving 21 acres, the total losses were estimated at about 1,000 pounds. In 1913, reports were made on 525 acres. No losses were reported on 56 out of 61 farms; slight losses were reported on three and serious losses on two. In one of these cases the loss was reported as 25 per ct. of the crop on 6 acres and was probably greater; in the other, a 40 per ct. loss of crop on 10 acres. In both cases the sulphuring had been neglected. In 1914, the final survey included 476 acres on 57 farms. No losses were reported on 33 farms; on 21 farms losses were reported as slight; and in three yards as heavy. In one case a loss estimated at 1,800 pounds occurred, apparently due to neglect of sulphuring early in the season. In a second case, where a large amount of mildew was present early, the yards were reported in good shape at picking time except one acre. In a third case but few hops were picked on a seven-acre yard which had been sulphured but not frequently or heavily enough, considering the amount of mildew present early. The yard was dusted four times using about thirty pounds per acre. This amount proved entirely inadequate.

No record has been made of the conditions in yards outside the association though the writer has had occasion to observe them for the past several years. In many cases growers not in associations have sulphured quite as thoroughly or more so than those inside. In some communities some of the leading growers began sulphuring in 1911 and were largely copied by their neighbors. In other communities, no sulphuring was done in 1911 and 1912, or only halfheartedly done. During picking time in 1912, hundreds of acres of hops never picked were seen in such neighborhoods. A few yards usually escape the mildew for a year or two without treatment, but these are rare. The result has been that in communities where sulphuring was not begun, complete losses have been the rule and it has proven necessary to abandon hop culture altogether, or adopt the treatment. One such section was particularly noticeable in the fall of 1913. Nearly two-thirds of the hop yards were not picked or only partly picked. A large part of those picked were of extremely poor quality. In the season of 1914 a great improvement was made in this same section even under the more adverse conditions. A few yards not picked were seen but these were comparatively rare as compared with the year previous.

LIME-SULPHUR VS. BORDEAUX MIXTURE AS A SPRAY FOR POTATOES. III.[*]

M. T. MUNN.

SUMMARY.

The experiments described in this bulletin are, in the main, repetitions of experiments made in 1911 and 1912 and reported in Bulletins 347 and 352. The results agree essentially with those previously obtained. They show that lime-sulphur is harmful rather than beneficial to potatoes.

Bordeaux mixture prevented tip-burn to a considerable extent, made the foliage darker green, prolonged the period of growth and increased the yield.

Lime-sulphur, on the contrary, aggravated tip-burn, dwarfed the plants, shortened the period of growth and reduced the yield.

As neither early blight nor late blight appeared in the experiment field during the season nothing was learned concerning the comparative value of the different spray mixtures for the control of these diseases.

The experiment will be repeated in 1915.

INTRODUCTION.

Experiments made at this Station in 1911 and 1912 demonstrated the great superiority of bordeaux mixture over lime-sulphur as a spray for potatoes. The results of these experiments were so striking as to leave little doubt that lime-sulphur is not to be recommended for use on potatoes. Nevertheless, it was deemed advisable to repeat the experiment in 1913 and 1914, because of the uncertainty concerning the value of lime-sulphur as a preventive of the late blight (*Phytophthora infestans*) and rot. In the experiments in 1911, 1913 and 1914 there was neither late blight nor rot. In the 1912 experiment there was a light attack of blight followed by much rot, but as many plants in the lime-sulphur rows were already dead when the blight appeared no data on the fungicidal value of the lime-sulphur were obtained.

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[*] **A reprint of Bulletin No. 397, February, 1915.**

Jones and Giddings[1] compared the self-boiled lime-sulphur (Scott's mixture) with bordeaux mixture as a potato spray in Vermont. Four applications of the self-boiled lime-sulphur gave a gain of 37 per ct. over corresponding unsprayed plats, while four applications of bordeaux mixture gave a gain of 141 per ct. or nearly four times that of the lime-sulphur.

Clinton[2] states that, in Connecticut, in a season with a little injury from blight late in the season, spraying potatoes with commercial lime-sulphur did not prolong the life of the vines or give increased yields, while spraying with bordeaux mixture did.

Safro[3] conducted experiments in Oregon to ascertain the chemicals occurring in the lime-sulphur spray that were injurious to foliage. "A 1 percent solution, approximately equivalent to 1 to 35 dilution, probably stronger, sprayed upon potato foliage, was not injurious except in one experiment where the plant was drenched heavily with the polysulfides."

Greene and Maney[4] in the Iowa experiment, sprayed two duplicate 1–20th acre plats with 5–5–50 bordeaux mixture and summer strength lime-sulphur. Plats receiving five applications of the lime-sulphur out-yielded, by 12.4 bushels of marketable tubers, the bordeaux plats to which five applications were given.

Macoun[5] in experiments at the Central Experimental Farm, Canada, made one application of commercial lime-sulphur 1–35, and 6–4–40 bordeaux mixture to one row 33 feet long of each of nine varieties of potatoes. The bordeaux rows out-yielded the unsprayed rows by 77 bushels marketable potatoes per acre, and the lime-sulphur rows out-yielded the unsprayed rows by 13 bushels marketable tubers per acre.

Dr. Pethybridge[6] has reported the results of an experiment in Ireland in which three applications of lime-sulphur solution proved utterly useless as a preventive of blight and rot. Probably, similar results are to be expected in America; yet it seems worth while to continue our experiments until the occurrence of an epidemic of blight furnishes an opportunity for a thorough test.

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[1] Jones, L. R., and Giddings, N. J. Vt. Sta. Bul. 142:112–114. 1909.

[2] Clinton, G. P. Report of the Station Botanist 1909–1910. Conn. Sta. Rpt. 1909–1910:743. 1911.

[3] Safro, V. I. Oregon Sta. Research Bul. 2:1913.

[4] Greene, L., and Maney, T. J. Iowa Sta. Bul. 149:1914.

[5] Macoun, W. T. Report of the Dominion Horticulturist. Rpt. of Experimental Farms, Canada, 1913. p. 303.

[6] Pethybridge, G. H. Investigations on Potato Diseases (Third Report). *Journ. Dept. Agr. and Tech. Instr. Ireland* 12:339. 1912.

A second object of the experiment in 1913 was to determine the effect of spraying potato foliage with milk-of-lime.[7]

THE EXPERIMENT IN 1913.

PLAN, METHODS, AND MATERIALS.

The plat of land devoted to the experiment in 1913 was 290 x 66 feet. It contained twenty-two rows, each having an area of one-fiftieth acre. After excluding one row on each side as an outside row, the remaining twenty rows were divided into five series with four rows in each series. Row No. 1 of each series was sprayed with bordeaux mixture, Row No. 2 with lime-sulphur, Row No. 3 with milk-of-lime,[7] and Row No. 4 reserved as a check.

The bordeaux mixture used contained six pounds of copper sulphate and four pounds of lime to each fifty gallons of the spray solution. The lime-sulphur solution was prepared by diluting a concentrate testing 24° Beaumé at the rate of two gallons of the concentrate to fifty gallons of water. This makes a solution of the strength commonly recommended for spraying apple orchards, viz., 1 to 40 when the density of the concentrate is 32° Beaumé.

The first spraying was made on June 30 when the plants were about ten inches high. After this the bordeaux rows and lime-sulphur rows were sprayed once every two weeks until they had received six applications. "Bugs" were well controlled by adding three pounds of arsenate-of-lead paste to each fifty gallons of spray mixture used in the applications of June 30 and July 13. On the same dates the check rows were treated with the same quantity of arsenate-of-lead in water with equally good results.

The spray mixtures were applied very thoroughly with a knapsack sprayer at the rate of 150 to 200 gallons per acre in each application.

The potatoes were of the variety Sir Walter Raleigh, and the seed pieces were placed fifteen inches apart by the use of gage-rods.

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[7] A report upon the results obtained by the use of milk-of-lime and other sprays upon potato foliage will be issued later.

EFFECT OF THE SPRAY MIXTURES ON THE FOLIAGE.

At the outset it should be stated that no early blight (*Macrosporium solani*), or late blight (*Phytophthora infestans*), occurred in the experimental field during the season. Therefore nothing was revealed as to the comparative value of the preparations as preventives of potato blight.

At the time the first application of the spray mixtures was given (June 30), the plants were about ten inches high, even all over the field, and growing vigorously. Previous to the second spraying all the rows appeared very uniform in size and color of foliage, but on July 21, one week following the second spraying, it was first noticed that the bordeaux rows presented slightly greener foliage than did the lime-sulphur or the unsprayed rows. On July 28, at the time of the third spraying, the difference in color of foliage noted the week previous was more marked and in addition it was observed that the plants in the lime-sulphur rows did not stand as erect as plants in the other rows and appeared to be somewhat smaller. On August 4 it could be plainly seen that the bordeaux rows were far superior to the lime-sulphur rows, having heavier foliage of a darker green color. The lime-sulphur rows were inferior to the check rows. They showed considerable tip-burn, the lower branches bore many yellow and dead leaves, and in some cases the entire plant was nearly dead.

Notes taken August 18, seven weeks after the first spraying, read as follows: "The condition of the foliage as shown by the different rows is particularly striking at this time, possibly because of the dry weather. The foliage of plants in the bordeaux rows is of a darker green color than in any of the other rows, it being decidedly greener than in the lime-sulphur rows. The bordeaux rows show but little tip-burn and the leaves on these appear larger than those on the other rows." "The lime-sulphur rows show a very inferior condition as compared with the other rows. The plants in these rows show considerable tip-burn and yellowing of the foliage. In some cases whole branches, and occasionally an entire plant, are dead. Plants do not stand as erect as in other rows. As a whole, the plants in these rows present such an unthrifty appearance as to be noticeable at some distance."

Flea-beetle injury, while very slight, was found to be more prevalent on the lime-sulphur and unsprayed rows than on the bordeaux rows.

On September 15 a heavy frost occurred, killing a considerable number of the then living plants in the lower portion of the field and thereby making spraying and further comparison impossible. Just previous to this date the bordeaux rows were in much better condition than the check rows, some plants of the former holding heavy foliage. The lime-sulphur rows were greatly inferior to the other rows, many of the plants in these rows being dead about two to three weeks.

From the season's observations and comparisons upon the foliage it can be stated that tip-burn was the most serious trouble. The bordeaux rows were nearly free from this trouble during the entire season, while on the lime-sulphur rows it appeared as if the trouble was aggravated by the lime-sulphur spray. The yellowing of the foliage upon the lime-sulphur rows, more especially that of the lower branches, took place early in the season and was followed by a browning and dying of the leaves which appeared cumulative. A large percentage of the plants in these rows were completely dead several days before many plants had died in the check rows. It appeared that the action of the bordeaux mixture was rather in the direction of checking or retarding the yellowing, and later, browning and dying of the foliage, since these rows were much freer from this trouble than were the check rows.

The bordeaux mixture had a decided influence upon the color of the foliage. Three weeks after the first spraying it was noticed that the leaves of plants sprayed with bordeaux mixture began to assume a deeper green or darker color of foliage than the lime-sulphur or the unsprayed rows. This darker color increased to a certain extent and was retained until late in the season after the bordeaux-blue coating of spray was mostly washed away.

YIELDS.

The following table shows the kind of treatment, also the yield of potato tubers as determined by carefully sorting and weighing each row separately at the time of digging:

TABLE I.— COMPARATIVE YIELDS OF POTATOES SPRAYED WITH BORDEAUX MIXTURE AND LIME-SULPHUR DURING 1913.

Row No.	Kind of treatment.	YIELD PER ROW.		COMPUTED YIELD PER ACRE.		
		Marketable tubers.	Small tubers.	Marketable tubers.	Small tubers.	Total yield.
		Lbs.	*Lbs.*	*Bu.*	*Bu.*	*Bu.*
1...	Bordeaux mixture	170.5	18.5	142.1	15.4	157.5
2...	Lime-sulphur	136.0	15.0	113.3	12.5	125.8
3...	(See footnote)*	......	......	......	......	....
4...	Check	156.0	15.0	130.0	12.5	142.5
5...	Bordeaux mixture	195.5	16.0	162.9	13.3	176.2
6...	Lime-sulphur	117.0	12.0	97.5	10.0	107.5
7...		......	......	......	......	......
8...	Check	162.5	16.5	135.4	13.7	149.1
9...	Bordeaux mixture	178.0	15.5	148.3	12.9	161.2
10...	Lime-sulphur	132.0	13.5	110.0	11.2	121.2
11...		......	......	......	......	....
12...	Check	143.5	15.0	119.6	12.5	132.1
13...	Bordeaux mixture	176.0	11.0	146.6	9.1	155.7
14...	Lime-sulphur	116.0	13.0	96.6	18.0	114.6
15...		......	......	......	......	....
16...	Check	136.5	22.0	113.7	18.3	132.0
17...	Bordeaux mixture	163.0	17.5	135.8	14.5	150.3
18...	Lime-sulphur	113.0	18.5	94.1	15.4	109.5
19...		......	......	......	......	....
20...	Check	127.0	19.0	105.8	15.8	121.6

* Rows 3, 7, 11, 15 and 19 were sprayed with milk-of-lime. A report upon the use of milk-of-lime and other coating sprays will be issued later.

TABLE II.— SUMMARIZED YIELDS OF POTATOES SPRAYED WITH BORDEAUX MIXTURE AND LIME-SULPHUR DURING 1913.

Kind of treatment.	AVERAGE YIELD PER ACRE.		
	Marketable tubers.	Small tubers.	Total.
	Bu.	*Bu.*	*Bu.*
Bordeaux mixture	147.2	13.0	160.2
Check, unsprayed	120.9	14.5	135.4
Lime-sulphur	102.3	13.4	115.7

Gain from use of bordeaux mixture 24.8 *bu. tubers per acre.*
Loss from use of lime-sulphur 19.7 *bu. tubers per acre.*

The above table shows an increase in yield due to the use of bordeaux mixture, and a decrease in yield as a result of the use of lime-sulphur as a potato spray. The results obtained are not as striking as those secured in the previous two years. This may be due to

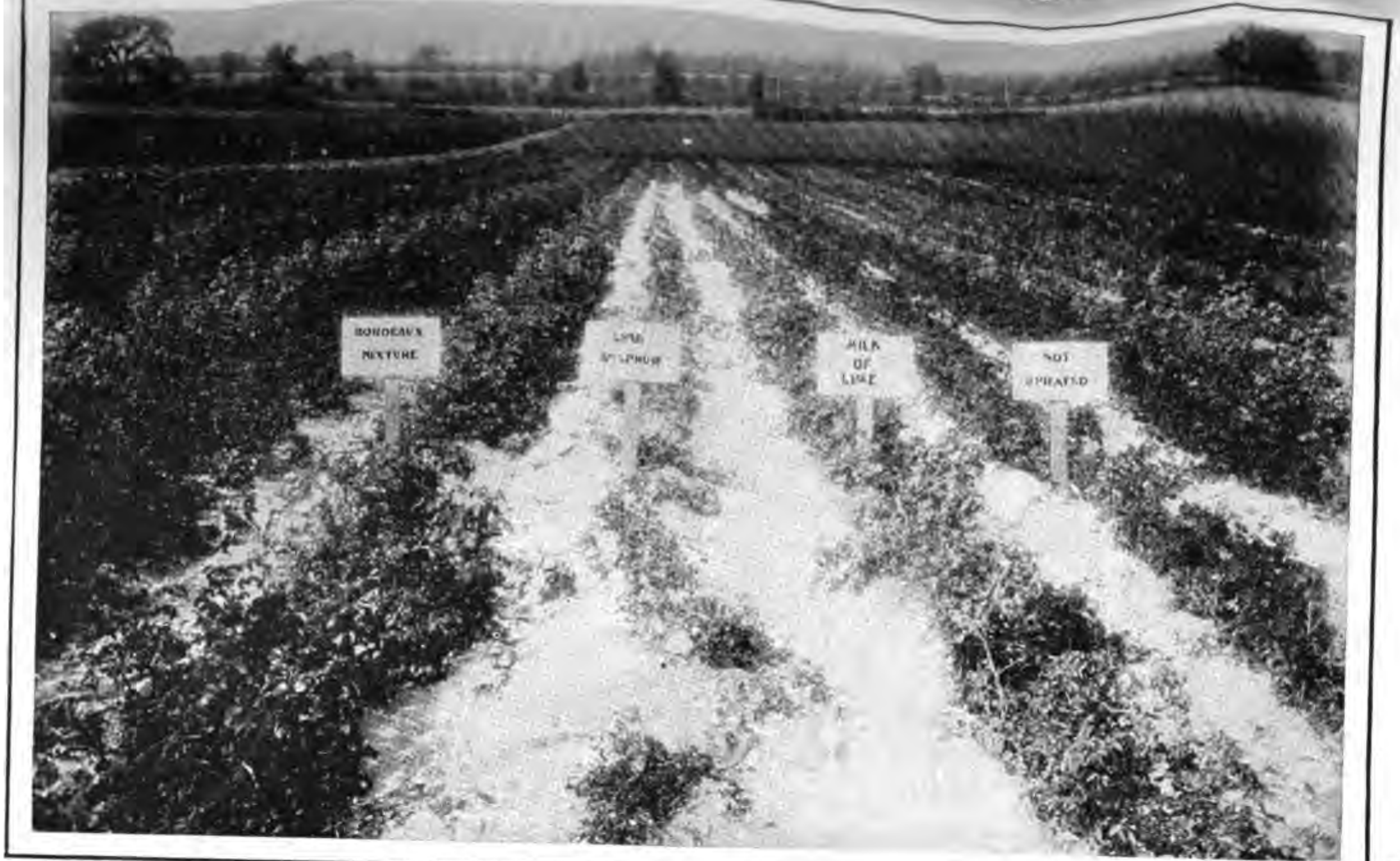

PLATE XII.—VIEW FROM SOUTH END OF EXPERIMENTAL FIELD ON SEPTEMBER 15, 1913.
Bordeaux rows in full foliage; lime-sulphur rows entirely dead; check or unsprayed rows

UNIV. OF MICH.

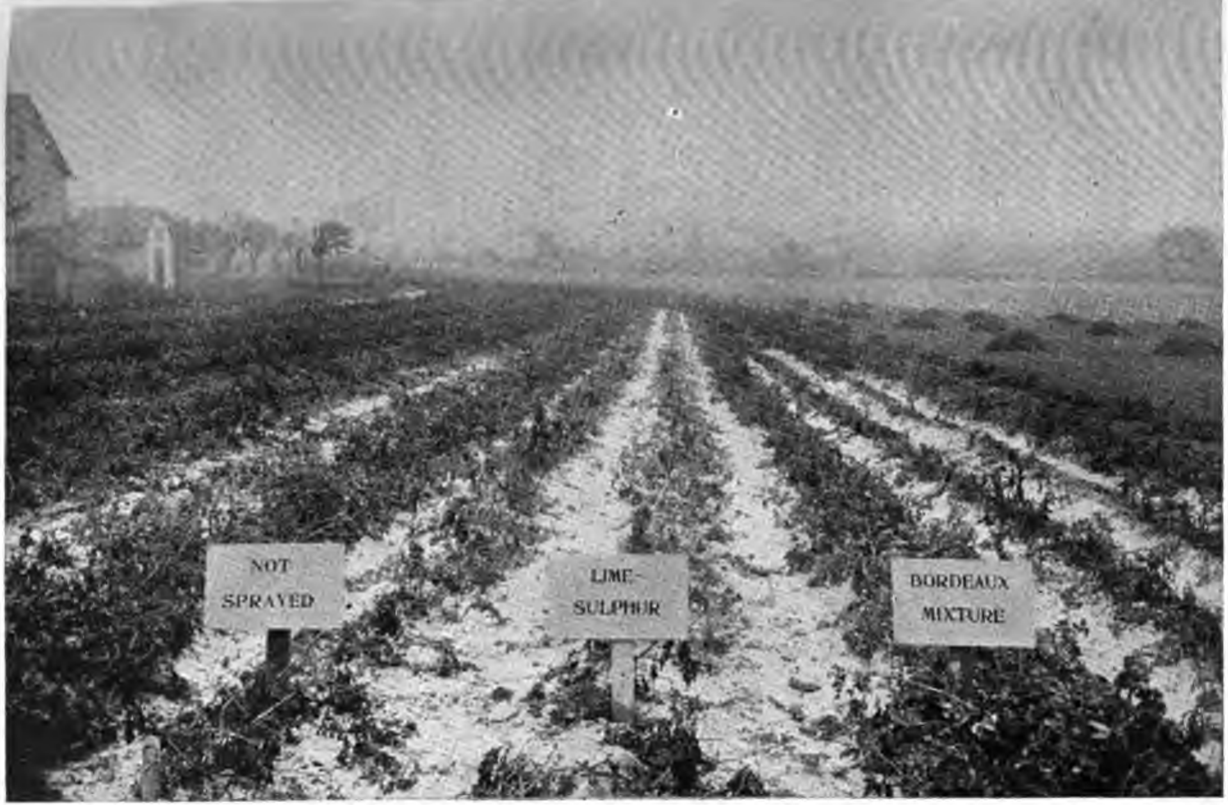

PLATE XIII.—VIEW FROM SOUTH END OF EXPERIMENTAL FIELD ON OCTOBER 14, 1914.

Lime-sulphur and unsprayed rows had been dead about two weeks; bordeaux rows holding considerable green foliage.

UNIV. OF MICH.

the short growing season (109 days) which lessened the effect of the bordeaux mixture spraying, since the bordeaux rows were holding quite heavy foliage at the time of the first killing frost which occurred early in the season, while the lime-sulphur rows had been dead about two weeks. A little difference in the condition of the foliage may represent a large difference in tuber yield.

THE EXPERIMENT IN 1914.

PLAN, METHODS, AND MATERIALS.

The plat of land devoted to the experiment in 1914 was 290 x 48 feet. It contained 16 rows, each having an area of one-fiftieth acre. After excluding one row on one side of the field as an outside row the remaining fifteen rows were divided into five series with three rows in each series. Another potato field adjoining the plat on one side made an outside row on that side unnecessary. Row No. 1 of each series was sprayed with bordeaux mixture, Row No. 2 with lime-sulphur, and Row No. 3 was reserved as a check.

The potatoes were of the variety Sir Walter Raleigh, and the seed pieces were placed fifteen inches apart by the use of gage-rods.

On July 7, when the plants were about ten inches high, the first application of the spray solutions was made, using the 6–6–50 bordeaux mixture and the 1 to 40 lime-sulphur solution. To control the "bugs" arsenate-of-lead paste at the rate of five pounds to fifty gallons of water was applied to the entire area with a horse sprayer. This application of the poison controlled the " bugs " for the season.

The bordeaux mixture and the lime-sulphur solutions were applied every two weeks throughout the season. A knapsack sprayer was used and the solutions applied very thoroughly at the rate of 150 to 200 gallons per acre in each application. Six applications were made during the season.

EFFECT OF THE SPRAY MIXTURES ON THE FOLIAGE.

On July 7, when the first application of the spray solutions was made the plants were very uniform in size and even over the entire area. On August 5, at the time of the third spraying no noticeable difference could be seen in case of any of the rows. Rains had been frequent and the entire area was very even and growing vigorously. August 12 was the first date when it was evident that the lime-sulphur rows were showing signs of dwarfing. The plants in these rows were not as erect in growth and appeared smaller in size. These differences became more marked, and on August 27, shortly after the fourth spraying, the lime-sulphur rows were plainly smaller than the other rows. The bordeaux rows were more upright and holding heavier foliage. The amount of tip-burning on the bordeaux rows was considerably less than on the lime-sulphur and check rows which appeared to be about equally affected.

On September 8, or just previous to the fifth spraying, these differences were still more marked. The lime-sulphur rows were distinctly dwarfed and the amount of tip-burn had increased on these rows and to some extent on the unsprayed rows. Until about September 10 the season was very favorable for the growth of potato foliage, but after that date no heavy rains occurred for a short period and the weather was somewhat dry and warm. It was during this period that the greatest changes in appearance of the potato plants took place. On September 21, at the time of the sixth spraying, the lime-sulphur rows were plainly inferior to the unsprayed rows. These rows showed considerably more tip-burn and browning and dying of the foliage than did the unsprayed rows. The bordeaux rows maintained their darker green color of foliage.

On September 23, or two days following the sixth spraying, a heavy rain occurred which was followed by very warm, partly cloudy weather. This weather condition appeared to greatly aggravate the condition of the foliage on the lime-sulphur rows. The leaves became yellow, which was followed by browning, and, later, many of the lower branches and in some instances whole plants became brown and dead. On October 3 the checks or unsprayed rows were plainly better than the lime-sulphur rows. The bordeaux rows were holding nearly full foliage, there being only a few dead brown leaves on these plants.

The most striking contrast, as to the effects of the different kinds of foliage treatment, was evident on October 14 when the plants in the bordeaux rows first began to turn brown and die. These rows held quite heavy, green foliage until about this date, while the lime-sulphur and check rows had been dead at least ten days to two weeks. The beneficial influence of the bordeaux mixture as evidenced by the darker green foliage had been increasingly apparent since the time of the third spraying on August 12.

YIELDS

The following table shows the kind of treatment, also the yield of tubers as determined by carefully sorting and weighing each row separately at the time of digging:

TABLE III.— COMPARATIVE YIELDS OF POTATOES SPRAYED WITH BORDEAUX MIXTURE AND LIME-SULPHUR DURING 1914.

Row No.	Kind of treatment.	Yield Per Row.			Computed Yield Per Acre.		
		Marketable tubers.	Small tubers.	Total yield.	Marketable tubers.	Small tubers.	Total yield.
		Lbs.	*Lbs.*	*Lbs.*	*Bu.*	*Bu.*	*Bu.*
1...	Check.............	362.0	24.0	386.0	301.6	20.0	321.6
2...	Lime-sulphur......	361.0	28.0	389.0	300.8	23.3	324.1
3...	Bordeaux mixture..	489.0	26.0	515.0	407.0	20.6	427.6
4...	Check.............	381.0	27.0	408.0	317.5	22.5	340.0
5...	Lime-sulphur......	361.0	23.0	384.0	300.8	19.1	319.9
6...	Bordeaux mixture..	515.0	28.0	543.0	429.1	23.3	452.4
7...	Check.............	400.0	25.0	425.0	333.3	20.8	354.1
8...	Lime-sulphur......	381.0	17.5	398.5	317.5	14.5	332.0
9...	Bordeaux mixture..	494.0	28.0	522.0	411.6	23.3	434.9
10...	Check.............	368.5	23.5	392.0	307.0	19.5	326.5
11...	Lime-sulphur......	361.0	12.5	311.0	300.8	10.4	311.2
12...	Bordeaux mixture..	503.0	17.0	520.0	419.1	14.1	433.2
13...	Check.............	382.5	22.0	404.5	318.7	18.3	337.0
14...	Lime-sulphur......	353.0	20.0	373.0	294.2	16.7	310.9
15...	Bordeaux mixture..	524.0	18.0	542.0	436.6	15.0	451.6

TABLE IV.— SUMMARIZED YIELDS OF POTATOES SPRAYED WITH BORDEAUX MIXTURE AND LIME-SULPHUR DURING 1914.

Kind of treatment.	Average Yield Per Acre.		
	Marketable tubers.	Small tubers.	Total.
	Bu.	*Bu.*	*Bu.*
Bordeaux mixture......................	420.6	19.2	439.8
Check, unsprayed......................	315.6	20.2	335.8
Lime-sulphur..........................	302.8	16.8	319.6

Gain from use of bordeaux mixture 104.0 *bu. tubers per acre.*
Loss from use of lime-sulphur 16.2 *bu. tubers per acre.*

DISCUSSION OF RESULTS.

The experiments of the past two seasons were designed, in part, to supplement the data obtained in the work of the two preceding seasons, hence, in a discussion of results obtained by lime-sulphur and bordeaux spraying upon potatoes, it is advisable to take into consideration these obtained in the previous two experiments.

The following table summarizes the results of the four seasons' tests with the lime-sulphur solution and bordeaux mixture on potatoes. Length of growing season, number of applications and comparative yields are given:

TABLE V.—SUMMARY OF RESULTS OF FOUR SEASONS' TESTS WITH LIME-SULPHUR AND BORDEAUX MIXTURE ON POTATOES.

	1911	1912	1913	1914	Average
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Gain from use of bordeaux mixture..	100.3	48.2	24.8	104.0	69.3
Loss from use of lime-sulphur.......	39.5	39.1	19.7	16.0	28.5
Number of applications of spray....	6	6	6	6	
Length of growing season in days*...	158	146	109	142	

* Length of growing season is time between date of planting tubers and first killing frost.

The results obtained during the four years are of a confirmatory character and tend to show that where the productive life of the potato field was continued for a longer length of time than usual a considerable increase in tuber yield resulted. The decrease in tuber yield on the lime-sulphur rows was due to the dwarfing effect of the solution associated with the loss of foliage during the latter part of the season. The factors influencing or causing injury to potato foliage from the lime-sulphur solution are thought to be constant since the injury each season appeared to be similar in character and cumulative regardless of weather conditions.

In the last three seasons' tests it was noted that there was a marked difference in the size of tubers from the rows under different kinds of treatment. Many of the tubers from the bordeaux rows were somewhat larger than those from the check rows and considerably larger than those from the lime-sulphur rows.

The bordeauxed rows held their foliage several days longer than the unsprayed rows and from two to three weeks longer than the lime-sulphur rows, hence the results are very much in favor of bordeaux mixture, while lime-sulphur cannot be recommended as a spray for potatoes.

CONCLUSIONS.

The results of the past two seasons' work are entirely confirmatory of the experiments of the previous two seasons. The relative efficiency of the two sprays, as far as their effect upon potato foliage and tuber yield is concerned, can be definitely stated. Bordeaux mixture, because of its beneficial influence upon the leaves, materially lengthens the productive life of the potato plants resulting in a marked increase in yield of tubers. The lime-sulphur solution, because of its injurious effect in dwarfing the plants and aggravating tip-burn, causes the plants to die ten days to two weeks earlier than those in unsprayed rows and materially decreases the yield of tubers.

The effect of lime-sulphur on late blight and rot (*Phytophthora infestans*) is still uncertain, since it appeared in the experimental field in but one of four seasons' tests at which time it apparently failed to check the disease.

It seems certain, then, that lime-sulphur should not be used as a potato spray, while on the other hand it pays to spray potatoes every season with bordeaux mixture, because the bordeaux mixture prevents tip-burn, prolongs the life of the plants, and increases the yield in dry seasons, while in wet seasons the protection against late blight with its resulting tuber rot, may result in marked gains. Potato growers should not omit the spraying of potatoes with bordeaux mixture.

THE SPINDLING-SPROUT DISEASE OF POTATOES.[1] *

F. C. STEWART AND F. A. SIRRINE.

SUMMARY.

The superiority of northern-grown over southern-grown seed potatoes is well known, but the explanation of it is not clear.

On Long Island, in the spring of 1914, there was much complaint of the poor condition of potato fields planted with home-grown seed. The stand was very uneven. There were many small, weak plants with very slender stems and, in some fields, many missing hills.

Upon investigation it was found that the weak plants and missing hills were, in most cases, the consequence of using, for seed, tubers which produce slender, thread-like sprouts. That is to say, the trouble was due to a weakened or debilitated condition of the seed tubers for which the writers propose the name spindling-sprout disease.

The cause of spindling-sprout is not definitely known though excessive heat and drought are suspected of being responsible for it. On Long Island, the weather in the summer of 1913 was very hot and dry. A similar disease, perhaps identical with spindling-sprout, occurs in parts of Europe, but plant pathologists are not agreed as to its cause.

Although, under exceptional conditions, spindling-sprout may occur as far north as Canada, it is chiefly a trouble of southern-grown seed. Hence the use of northern-grown seed is a means of avoiding it.

Long Island potato growers using home-grown seed should make a sprouting test of their seed potatoes. The appearance of spindling sprouts may be regarded as an indication that the seed is unfit for planting.

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[1] A brief abstract of this paper was published in *Phytopath.* 4:395. Dec. 1914.

* A reprint of Bulletin No. 399, March, 1915.

NORTHERN-GROWN VS. SOUTHERN-GROWN SEED.

Potato growers in the Southern States use large quantities of northern-grown seed. Their experience leads them to believe that better stands and larger yields are obtained from northern-grown than from southern-grown seed. Moreover, the results of numerous experiments in England and America indicate the superiority of northern-grown seed potatoes. It appears that, in some manner not fully understood, potatoes are debilitated by growing in a warm climate. Even as far north as Long Island the place of origin of seed potatoes is considered important. However, on Long Island, popular opinion on the subject is somewhat divided. While the prevailing opinion favors northern-grown seed it is a fact that large quantities of home-grown seed are planted every year. Some plant northern seed every other year and home-grown seed in the alternate years. Others follow the practise of planting each year a small quantity of northern seed to raise tubers with which to plant the principal part of their acreage the following year. Some use seed which has been grown on Long Island two or three years in succession.

In some seasons little fault is found with home-grown seed. In fact it happens, frequently, that home-grown seed gives better stands than northern-grown seed; but in other seasons there is much complaint about poor results from home-grown seed.

SPINDLING-SPROUT ON LONG ISLAND IN 1914.

During the season of 1914 such complaint was general. Almost every field planted with home-grown seed was in poor condition. There were many missing hills and the plants which grew varied much in size. Many plants were small and weak and had very slender stems. Some fields were in such poor condition that it was deemed advisable to plow them and replant the land with some other crop.

Upon making an inquiry into the cause of the trouble it was discovered that, in nearly every case, it was due, principally, to a weakness in the seed which we will call spindling-sprout disease. The following account of observations on an affected field near Riverhead will indicate the nature of the disease and the symptoms by which it may be recognized: The seed potatoes used in this field belonged to the variety Green Mountain. They were grown on Long Island in the season of 1913 from Maine seed. The crop of that year was light owing to the unusually hot, dry weather, but, so far as observed, the plants showed no symptoms of spindling-sprout or other disease. During the winter of 1913–14 the potatoes were stored in crates in an unheated cellar where they appeared to keep well. At planting time in the spring of 1914 they were sound and plump and seemed to be in excellent condition except that they had sprouted to a considerable extent. At this time it was observed that some of the sprouts appeared weak, but little attention was given to the matter. During the handling incident to treatment with formaldehyde solution for scab most of the sprouts were destroyed. The tubers were afterwards cut and planted, April 24, about three inches deep with a Robbins potato planter. The soil was sandy loam thoroughly fitted and moist. Following planting the temperature and moisture conditions were favorable for the sprouting of potatoes.

Soon after the plants began to appear above ground it became evident that something was wrong. When some plants were six or seven inches high others were just breaking through the soil and there were, also, a good many blank spaces. It looked as if there would be a poor stand. Upon digging up the small plants it was found that they had very slender stems. Some seed pieces, though perfectly sound, had not started any sprouts. Others had put out sprouts which were so slender as to be scarcely recognizable as potato sprouts and too weak, apparently, to push their way through the soil. No lesions of any kind were found on the sprouts or stems and there was no rotting of the seed pieces. The trouble seemed to be due to some weakness of the seed.

Fortunately, several bushels of the uncut seed potatoes had been left over from planting. They had been stored in the cellar in crates. By this time they all bore sprouts from one to two inches in length. An examination of these tubers threw much light on the problem. While about two-thirds of the tubers bore normally robust sprouts the remainder bore exceedingly slender sprouts like those observed in the field. (See Plate XIV.) The contrast in appearance between tubers bearing the two kinds of sprouts was striking. All the sprouts on a tuber were stout or else all were very slender. Stout and slender sprouts did not occur on the same tuber

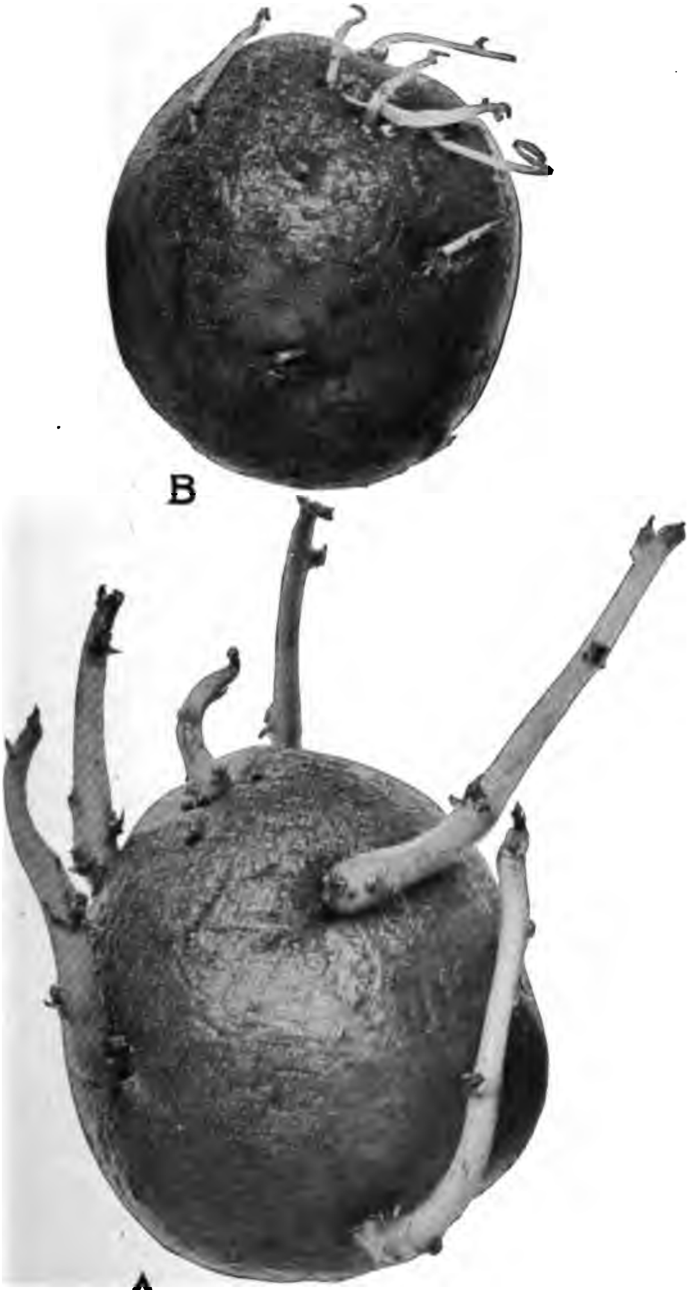

Plate XIV.— Spindling-Sprout Disease of Potato Tubers.
A, normal; B, affected with spindling-sprout. (Natural size.)

and tubers bearing sprouts intermediate in size were not common. In general, the sprouts were either of normal size or else very slender. Small, secondary tubers were of frequent occurrence on the slender sprouts. A careful examination failed to reveal any difference, other than the size of the sprouts, by means of which the weak tubers might be distinguished from the normal ones. There were no lesions of any kind and no discoloration either internally or externally. Tubers of all sizes were affected. In a cooking (boiling) test the two kinds of tubers appeared equal in quality.

These observations on the left-over tubers strengthened the suspicion that the trouble in the field was due to a weakness of the seed; but in order to definitely connect the spindling-sprouted tubers with the weak, slender-stemmed plants observed in the field, the following experiment was made: Twenty-five tubers with spindling sprouts and sixteen with normal sprouts were taken to Geneva and planted whole. Contrary to expectations every tuber produced a plant. All plants from the spindling-sprouted tubers were small, weak and slender-stemmed exactly like the plants observed in the field at Riverhead. Although in rich soil and given good cultivation and care, including thorough spraying with bordeaux mixture, the plants remained small to the end of the season. They showed no wilting, rolling, curling or spotting of the leaves, no lesions on the stems or other pathological symptoms. Neither did they die prematurely. They were simply small. The tubers produced were small but otherwise normal in appearance. The average yield per hill was only 8.6 ounces. Under similar conditions the normal-sprouted tubers, with one exception, produced strong, large plants which gave an average yield of 21.5 ounces per hill.

Returning, now, to the field at Riverhead: By the middle of June it was evident that the condition of the field was considerably better than our earlier observations had indicated. Estimates made at this time showed about 95 per ct. of a full stand with about 29 per ct. of the plants distinctly smaller than normal.

Similar observations were made in other fields. In one case a farmer called the writers' attention to the condition of his seed potatoes shortly before planting time. The potatoes were home-grown and of the variety Norcross. Being stored in a warm cellar they had commenced to sprout. Many were producing spindling sprouts. This caused the owner to suspect that the tubers were weak and unfit for seed, but out of curiosity to see what they would do he planted a few bushels. The writers, also, planted about a bushel. Although a fair stand was obtained, over fifty per ct. of the plants in both cases were plainly below the normal in size, many being so small and weak that they were unable to produce any tubers of marketable size.

In previous years the writers have occasionally seen potato tubers which produced abnormally slender sprouts and more frequently heard of such cases. Also, they have observed on Long Island during the past twenty years a great many potato fields containing many small plants, the weak condition of which could not be accounted for satisfactorily; but it had never occurred to them that there was any relation between these two phenomena. However, an examination of the literature reveals the fact that this idea is not a new one.

SPINDLING-SPROUT, FILOSITÉ AND FADENBILDUNG.

Close and White[2] have described and illustrated spindling-sprout, pointed out its relation to weak plants in the field and shown that it is a factor in the low yields obtained from southern-grown seed. The spindling-sprout has been mentioned, also, by other American writers, but it has not received much attention.

It seems to have been spindling-sprout which Orton[3] had in mind when he wrote the following: " Premature ripening follows when potatoes bearing half-grown tubers are exposed to the midday heat of our Southern States. There is in addition to tipburn a yellowing and early death of the foliage. Potatoes produced in these southern conditions lose their constitutional vigor and germinate later, with small weak sprouts and give a smaller yield than seed from northern sources. This constitutional defect is not cured by restoration to a northern environment."

At the annual meeting of the New York Potato Association held in Ithaca last February, Prof. W. T. Macoun of Ottawa, Canada, stated positively that he has observed spindling-sprout at Ottawa among potatoes grown on light, sandy soil in the very dry season of 1905.

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[2] Close, C. P., and White, T. H. Irish potato investigations. Md. Sta. Bul. 132. 1909.

[3] Orton, W. A. Environmental influences in the pathology of *Solanum tuberosum*. *Journ. Wash. Acad. Sci.* 3:184. 1913.

The writers have seen one quite bad case of spindling-sprout among potatoes which were said to have been grown in Maine and potato growers have reported its occasional occurrence at several different points in New York. Hence it appears that spindling-sprout is not strictly confined to southern latitudes.

The cause of spindling-sprout is not definitely known; though hot, dry weather is suspected of being, in some way, responsible for it. On Long Island the summer of 1913 was an exceedingly hot and dry one.

In Europe there is a potato disease which is called by the French "filosité" and by the Germans "Fadenbildung" and "Fadenkrankheit." Some of its symptoms (spindling, thread-like sprouts) are very much like those which characterize spindling-sprout.[4] Although it remains yet to be determined whether this disease is the same as spindling-sprout it is interesting to compare the opinions of plant pathologists concerning its cause.

Appel[5] states that in the spring of 1912 potatoes in parts of Germany came up poorly with numerous weak shoots. He uses no name for the disease, but his description and illustration are very suggestive of spindling-sprout. He attributes this condition to the abnormally dry weather in the summer of 1911 which caused potatoes to ripen prematurely and sprout prematurely, thereby making it necessary to remove the sprouts several times previous to planting. This so weakened the tubers that they were unable to produce strong sprouts at planting time.

Certainly, the trouble on Long Island can not be satisfactorily explained in this way, because sprouts had been removed from the tubers but once previous to planting. Moreover, according to Appleman,[6] "Removing the sprouts repeatedly does not seem to weaken the buds for seed; the eighth crop of sprouts from the same buds was just as vigorous as the first."

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[4] The potato trouble illustrated by C. L. Fitch in one of his publications (Identification of potato varieties. Iowa State College of Agriculture and Mechanic Arts. Extension Bul. 20 : 5, fig. 1. 1914) is not *filosité* as we understand it, but rather one form of what the Germans call "Durchwachsen." (See Sorauer. Handbuch der Pflanzenkrankheiten, Dritte Aufl., 1:162. 1909.)

[5] Appel, [O]. Über Kartoffelkrankheiten. Vortrag gehalten im Klub bayerischer Landwirte zu München. Separatabdruck aus dem Bericht der General-Versammlung vom 13, 14 und 15 Januar 1913, p. 2.

[6] Appleman, C. O. Changes in Irish potatoes during storage. Md. Sta. Bul. 167:333. 1912.

According to Sorauer[7] *Fadenbildung* occurs abundantly only where light soil which heats easily has to undergo long periods of dry weather. This describes, exactly, the conditions on eastern Long Island in 1913. Sorauer's theory of the origin of *Fadenbildung* is as follows: "When the tubers, in immature condition, through forced ripening suffer a cessation of growth and are then harvested, the eyes have not yet attained their normal development. The shoots from these must, naturally, be weak. If such tubers are used for seed the following year under like culture these symptoms of weakness must gradually increase and lead to the result that, finally, only stems of the fineness of a thread are produced. Accordingly, the disease is the consequence of a continued cultural error, namely, an inadmissible shortening of the vegetative period."

The writers consider this theory untenable. It does not accord with known facts in regard to the behavior of immature seed potatoes. Some other factor besides the shortening of the vegetative period must enter into it. Immature tubers, grown in cool weather, are considered by some to be as good if not better than mature tubers for seed purposes.

Delacroix[8] regards *filosité* as a condition of degeneracy resulting from continued asexual propagation under unfavorable conditions. Excessive drought he considers a secondary factor.

Parisot,[9] on the other hand, advances an entirely different theory. He claims to have proven by means of experiments (the details of which are not given) that *filosité* proceeds from the intoxication of the tubers by the carbon dioxid gas resulting from their own respiration. After explaining how, in piles of potatoes, the quantity of carbon dioxid increases rapidly as the distance below the surface increases, he says: "It is easy to explain how it occurs that filosité is so common in the bottom of large piles, and the means of avoiding it."

It is well known that potato tubers are constantly taking up oxygen and giving off carbon dioxid; also, that, in the storage of seed potatoes, some provision should be made for ventilation; but the idea that lack of ventilation is a cause of spindling-sprout, we cannot accept without more evidence. We have observed nothing which indicates that the deep piling of potatoes in storage has such an effect.

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[7] Sorauer, P. Handbuch der Pflanzenkrankheiten. Dritte Aufl. 1:159–161. 1909.

[8] Delacroix, G. Sur la "filosité" des pommes de terre. Extrait du *Jour. Agr.* [Paris]. Dec. 1903.

[9] Parisot, F. La filosité de la pomme de terre. Bul. Mens. Off. Renseig. Agr. [Paris]. 9:21–24. 1910.

EXPERIMENTS WITH TUBERS IN HERMETICALLY SEALED JARS.

Along this line we have made several experiments with tubers in hermetically sealed jars. Large glass jars were filled with clean, dry tubers on which the sprouts were barely, if at all, started. The jars were then hermetically sealed with paraffin or sealing wax and placed in a darkened room at a temperature of 16° to 21° C. (60° to 70° F.). So long as they remained in the air-tight jars the tubers invariably refused to sprout while check tubers in unsealed jars sprouted freely. If removed within about ten days they afterwards sprouted, but a longer exposure in the jars resulted in the death and decay of the tubers. Whenever the tubers sprouted at all the sprouts were of normal size — there was no tendency toward the spindling-sprout condition. In one case tubers which had been in a sealed jar for nine days remained dormant for about ten days after removal and were thought to be incapable of sprouting, but sprouts of normal size finally appeared. Eleven of the tubers were planted whole. The plants were of normal size and appearance and gave a yield of twelve pounds which is a good crop considering the character of the soil in which the plants were grown.

Although it appears improbable that the widespread trouble with home-grown seed potatoes on Long Island in the spring of 1914 was due to faulty methods of storage, this phase of the subject requires further investigation.

OTHER DISEASES WITH SIMILAR SYMPTOMS.

It is quite possible that spindling, thread-like sprouts are not always due to the same cause; that is to say, there may be two or more distinct diseases having the spindling-sprout symptom in common. The existence of such widely different theories as to the origin of *filosité* and *Fadenbildung* suggests this, as do, also, the following observations of our own: Early in the spring of 1914 a farmer in Greene County sent us a quantity of tubers some of which were affected with one of the stem-end-browning diseases. There was a distinct browning in the vascular region at the stem end of the tuber. Diligent search by cultural and microscopical methods failed to discover any organism and the cause of the discoloration was not determined. The point of present interest is that after the tubers commenced to sprout the diseased ones could be readily distinguished from the healthy ones by the difference in the size of their sprouts. The diseased tubers, though of fair size and normal appearance externally, produced very slender sprouts. While not so small as the sprouts on Long Island tubers affected with spindling-sprout, they were plainly sub-normal. Twenty-five affected tubers were planted. The resultant plants had slender stalks and never attained normal size, but were entirely normal in other respects. The yield of tubers was small, but none of them showed any indication of stem-end browning. This disease is certainly different from the true spindling-sprout disease, yet affected tubers show a sprout condition which is similar to that which characterizes spindling-sprout.[10]

That the production of spindling sprouts may be one of the symptoms of yet another disease is shown by the following observations: In 1913 the senior author grew in his garden at Geneva a short row of potatoes of the variety Ionia. The plants were not watched for signs of disease, but it is known that they grew to large size and were still partly green when frost came about the middle of September. After digging, the tubers were stored in a cool cellar until planting time the following spring. On May 26, 1914, some of the tubers were used for planting about one hundred hills. By the time the larger plants were a foot high a marked unevenness in the size of the plants was noticeable and this became more conspicuous as the season advanced. About thirty of the plants were pronounced dwarfs with the leaves curled downward and the bushy appearance characteristic of the curly-dwarf disease. These plants died prematurely. The tubers which they bore were small, longer than normal and somewhat pointed at both ends, but not affected with stem-end browning. About thirty other plants grew thriftily, became large and yielded well.

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[10] The "spindle disease (*Persola tomentosum*)" briefly discussed and illustrated in *Jour. Dept. Agr. West. Aust.* 17 (1908), No. 5, p. 857, pl. 1, was probably of a similar nature. This idea is suggested by the statement that the diseased condition of the tubers might be detected by cutting them at the "tail end." The use of *Persola tomentosum* as if it were the name of the causal organism appears to be an attempt at a joke, though it may have been intended for *Periola tomentosa* Fr., a fungus which occurs on potato tubers. No organism bearing the name *Persola tomentosum* is known to the writers.

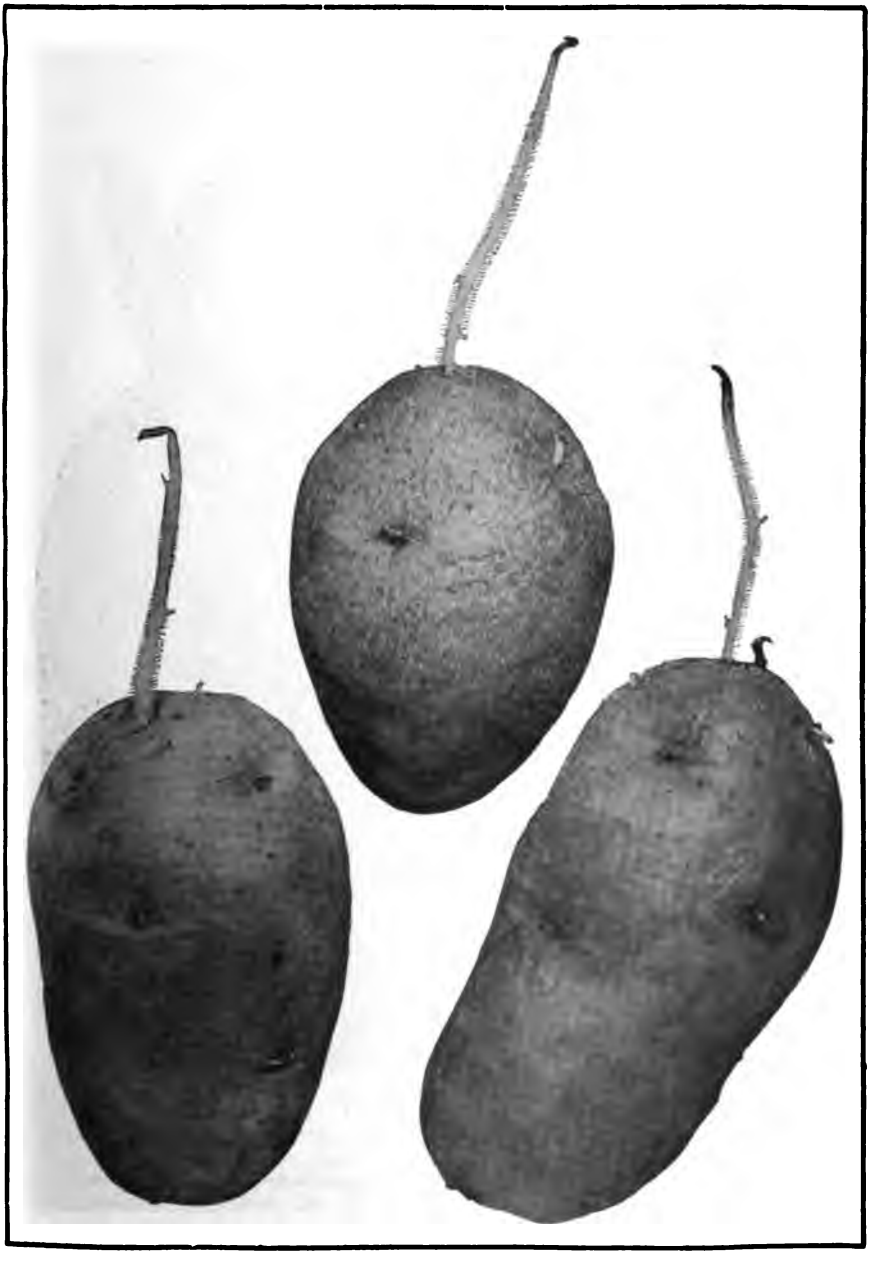

PLATE XV.— SPINDLING SPROUTS ON TUBERS FROM CURLY-DWARF PLANTS; VARIETY, IONIA. Compare with Plate XVI. (Natural size.)

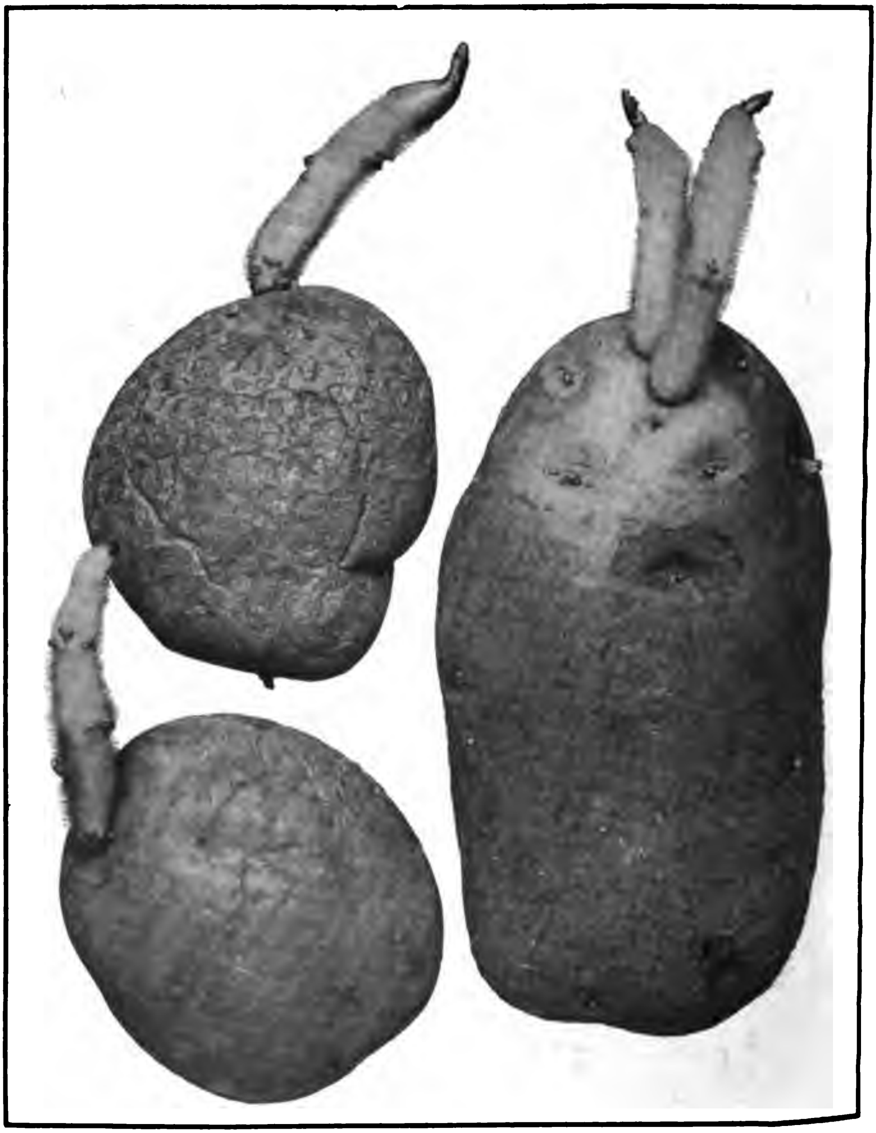

PLATE XVI.— NORMAL SPROUTING OF IONIA POTATO TUBERS.
(Natural size.)

The remaining forty plants were intermediate in character. Judging from their size and the downward curling of their leaves they were all more or less diseased, yet they yielded fairly well.

At digging time a few of the best and a few of the poorest hills were set aside for experiments in 1915. The remainder were thrown into a box and stored in a furnace-heated cellar. By the middle of March, 1915, the tubers in the box bore sprouts one to three inches in length. Some were normally robust, some moderately slender and many others extremely slender — typical spindling sprouts. (See plates XV and XVI.) Occasionally, large tubers showed robust sprouts at the bud end and slender sprouts growing from eyes near the stem end.

IS SPINDLING-SPROUT AN HEREDITARY DISEASE?

Orton's[11] statement that "this constitutional defect [spindling-sprout?] is not cured by restoration to a northern environment," suggests that spindling-sprout is an hereditary disease. Long Island potato growers who have planted the progeny of spindling-sprout tubers inform us that the results are always unsatisfactory. They say that the trouble seems to increase from year to year. Definite information based on actual experiments seems to be lacking.

However, Emerson's[12] experiments in Nebraska show that by growing seed potatoes under a mulch of straw it is possible not only to prevent the deterioration which occurs in a hot, dry climate under ordinary methods of culture, but actually to bring back to productiveness a stock which has become badly run down through cultivation. Whether spindling sprout was involved in these experiments is not known. No mention is made of the symptoms presented by the run-down potatoes.[13]

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[11] Orton, W. A. *Loc. cit.*

[12] Emerson, R. A. Home mulched vs. northern seed potatoes for eastern Nebraska. Nebr. Sta. Bul. 146. 1914.

[13] Replying to our inquiry on this point Prof. Emerson writes as follows: "I made no careful comparative observations on the sprouts of mulched and of cultivated tubers, nor did I compare directly the diameters of the plants as they stood in the field. I did, however, make a general observation that the cultivated tubers produced weaker plants than mulched tubers. My general impression of the differences between the plants of the two lots is not that the stems of one were decidedly more spindling than those of the other. The plants of the one lot were merely somewhat smaller, and if there was a difference in diameter of stems relative to height of the plant, it was not sufficient to impress me. The differences which I have noted were usually more pronounced early in the season than when the plants had nearly completed their growth."

The following experiment made by the writers shows that the progeny of tubers affected with spindling-sprout do not invariably produce spindling sprouts: Eight Geneva-grown tubers, four of which were the progeny of typical spindling-sprout tubers and the other four the progeny of normal-sprouted tubers, were induced to sprout in February by putting them in a dark place under a bench in a greenhouse. All of the tubers but one produced normally robust sprouts. The exception was a tuber of spindling-sprout parentage. The sprouts on this were abnormally slender though not as slender as those on the parent tuber.

MEANS OF AVOIDING TROUBLE WITH SPINDLING-SPROUT.

Since spindling-sprout occurs chiefly in southern-grown seed one way of avoiding it is to use only northern-grown seed. Another way is to make a sprouting test. Long Island farmers who contemplate using home-grown seed should always make a sprouting test before planting. This is especially important after a very dry season. From four to eight weeks before planting time a small quantity of the potatoes should be put in a warm, dark place to sprout. If all of the tubers produce strong sprouts it is safe to assume that the seed is suitable for planting; but if some of the tubers produce spindling-sprouts, the seed is not fit to plant. It seems as if this should be a simple method of avoiding trouble with spindling-sprout.

POTATO-SPRAYING EXPERIMENTS AT RUSH IN 1914.*

F. C. STEWART.

SUMMARY.

The potato-spraying experiments conducted at Rush, N. Y., in 1913 and reported in Bulletin 379 were repeated in 1914 on a somewhat larger scale. In each of 82 fields a portion of one row (one-fiftieth acre) was very thoroughly sprayed by hand every two weeks. At digging time the yield of this row was compared with that of an adjacent row which had not received the special spraying. In 56 of the fields no spraying was done by the owner. In these fields the test was a comparison between very thorough spraying and no spraying. In the other 26 fields more or less spraying was done by the owner. In these, the test was a comparison between very thorough spraying and the kind of spraying done by the owner.

In the 56 unsprayed fields the spraying done by the Station increased the average yield by 15.82 bushels per acre, or 8 per ct.; and in the 26 sprayed fields by 13.75 bushels per acre, or 5.5 per ct.

Owing to favorable weather, potato foliage was remarkably free from diseases and injuries of all kinds so that large returns from spraying were not to be expected. However, the absence of killing frost until late in October lengthened the usual period of growth and gave the bordeaux a good opportunity to exert its stimulative influence. Under these conditions, it seems as if the gain from spraying should have been larger.

A REPETITION OF THE EXPERIMENTS MADE IN 1913.

These experiments were conducted in the same manner as those made at Rush in 1913 and reported in Bulletin 379. In each of eighty-two potato fields a single row 290.4 feet long was sprayed with bordeaux mixture at intervals of two weeks throughout the season. In some cases seven applications were made and in others only six. The spraying was done very thoroughly by means of a knapsack sprayer. In fifty-six of the fields the owner used no bordeaux, but applied only such treatment as he considered necessary for the control of " bugs." In the remaining twenty-six fields more or less bordeaux was applied by the owner, the number of applications varying from one to seven.

*** A reprint of Bulletin No. 405, May, 1915.**

At digging time the row sprayed by the Station and an adjacent row of equal length were dug by hand and the product sorted and weighed. All of the spraying and weighing and most of the digging were done by Mr. E. B. Keyes of Rush, a brother of the young man who conducted the experiments in 1913.

During July and August the rainfall was somewhat scant, but in September it was sufficient for the needs of the crop. There was no late blight (*Phytophthora infestans*), no rot, no early blight (*Alternaria solani*), but little tipburn and no serious damage by flea beetles. Throughout the season the foliage was remarkably free from blemishes of all kinds. As there was no killing frost until late in October the plants had ample time to complete their growth. In most respects the season was an exceptionally favorable one for potatoes.

Table I shows the yields in the fifty-six experiments which were in unsprayed fields, while Table II shows the results of the twenty-six experiments in sprayed fields.

TABLE I.— RESULTS OF THOROUGH SPRAYING OF SINGLE ROWS IN FIFTY-SIX UNSPRAYED POTATO FIELDS.

Number of experiment.	UNSPRAYED.			SPRAYED BY THE STATION.			Yield per acre; marketable tubers.	Increase per acre due to spraying.
	YIELD PER ROW.		Yield per acre; marketable tubers.	Times sprayed.	YIELD PER ROW.			
	Marketable tnbers.*	Culls.			Marketable tubers.	Culls.		
	Lbs.	*Lbs.*	*Bu.*		*Lbs.*	*Lbs.*	*Bu.*	*Bu.*
1.......	178	0	148.3	7	295	0	245.8	97.5
2.......	239.5	0	199.5	6	318	0	265	65.5
3.......	244	0	203.3	6	311	0	259.1	55.8
4.......	169	0	140.8	7	233	0	194.1	53.3
5.......	159	7	132.5	7	211	6	175.8	43.3
6.......	273	0	227.5	6	321	0	267.5	40
7.......	222.5	7.5	185.4	6	269	8.5	224.1	38.7
8.......	183	4	152.5	6	229	3	190.8	38.3
9.......	286.5	0	238.7	7	330	0	275	36.3
10.......	278	0	231.6	7	317	0	264.1	32.5
11.......	316.5	0	263.7	6	355	0	295.8	32.1
12.......	281	0	234.1	6	319.5	0	266.2	32.1
13.......	190	9	158.3	6	227	8	189.1	30.8
14.......	300	0	250	6	334	0	278.3	28.3
15.......	231	0	192.5	7	263	0	219.1	26.6
16.......	267	0	222.5	6	298	0	248.3	25.8

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* A row 290.4 x 3 ft.= one-fiftieth acre. In some fields the rows were less than three feet apart. Nevertheless, in the computation of the acre yields given in Tables I and II the area of a row is assumed to be one-fiftieth acre in all cases.

TABLE I (*continued*).

Number of experiment.	UNSPRAYED.			SPRAYED BY THE STATION.			Yield per acre; marketable tubers.	Increase per acre due to spraying.
	YIELD PER ROW.		Yield per acre; marketable tubers.	Times sprayed.	YIELD PER ROW.			
	Marketable tubers.*	Culls.			Marketable tubers.	Culls.		
	Lbs.	*Lbs.*	*Bu.*		*Lbs.*	*Lbs.*	*Bu.*	*Bu.*
17.......	180	0	150	6	211	0	175.8	25.8
18.......	240	0	200	6	270	0	225	25
19.......	295	0	245.8	6	325	0	270.8	25
20.......	204	8	170	6	232	9	193.3	23.3
21.......	175	0	145.8	7	200	0	166.6	20.8
22.......	200	0	166.6	7	224	0	186.6	20
23.......	172	0	143.3	6	195	0	162.5	19.2
24.......	272	0	226.6	6	294	0	245	18.4
25.......	280	0	233.3	6	302	0	251.6	18.3
26.......	264.5	0	220.4	7	284	0	236.6	16.2
27.......	286	0	238.3	7	303	0	252.5	14.2
28.......	287	0	239.1	6	304	0	253.3	14.2
29.......	245	0	204.1	6	261	0	217.5	13.4
30.......	238	6	198.3	6	254	6	211.6	13.3
31.......	319	0	265.8	7	333	0	277.5	11.7
32.......	131.5	0	109.5	5	145.5	0	121.2	11.7
33.......	171	0	142.5	6	185	0	154.2	11.7
34.......	145	0	120.8	6	159	0	132.5	11.7
35.......	223	5	185.8	7	233	3	194.1	8.3
36.......	177	0	147.5	6	186	0	155	7.5
37.......	300	0	250	6	309	0	257.5	7.5
38.......	314	0	261.6	6	323	0	269.1	7.5
39.......	254	0	211.6	6	262.5	0	218.7	7.1
40.......	115	0	95.8	5	123	0	102.5	6.7
41.......	92	0	76.6	7	100	0	83.3	6.7
42.......	227	0	189.1	6	234	0	195	5.9
43.......	291	0	242.5	6	298	0	248.3	5.8
44.......	247	0	205.8	7	254	0	211.6	5.8
45.......	198	5	165	6	199.5	7	166.2	1.2
46.......	241	0	200.8	6	242	0	201.6	0.8
47.......	355	0	295.8	6	355	0	295.8	0
48.......	271	0	225.8	6	263.5	0	219.5	†—6.3
49.......	214	0	178.3	6	205	0	170.8	—7.5
50.......	279.5	5.5	232.9	6	269	5	224.1	—8.8
51.......	215	0	179.1	6	195	0	162.5	—16.6
52.......	220	0	183.3	6	199	0	165.8	—17.5
53.......	191.5	0	159.6	6	165	0	137.5	—22.1
54.......	385	0	320.8	6	350	0	291.6	—29.2
55.......	255	5	212.5	7	217	4	180.8	—31.7
56.......	341.5	0	284.5	7	298.5	0	248.7	—35.8

Average yield of unsprayed rows, 198.32 *bu. per acre.*

Average yield of the rows sprayed by the Station, 214.14 *bu. per acre.*

Average increase in yield per acre, 15.82 *bu. or* 8 *per ct.*

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* See note on p. 314.

† A minus sign indicates reduced yield.

TABLE II.—RESULTS OF THOROUGH SPRAYING OF SINGLE ROWS IN TWENTY-SIX SPRAYED POTATO FIELDS.

Number of experiments	SPRAYED ONLY BY OWNER.				SPRAYED ALSO BY STATION.				Increase per acre due to extra spraying by Station.
	Times sprayed.	YIELD PER ROW. Marketable tubers.	YIELD PER ROW. Culls.	Yield per acre; marketable tubers.	Times sprayed by Station.	YIELD PER ROW. Marketable tubers.	YIELD PER ROW. Culls.	Yield per acre; marketable tubers.	
		Lbs.	*Lbs.*	*Bu.*		*Lbs.*	*Lbs.*	*Bu.*	*Bu.*
57.......	5	153	3	127.5	7	229	3	190.8	63.3
58.......	4	254	4	211.6	6	327	8	272.5	60.9
59.......	1	245	4	204.1	7	297	5	247.5	43.4
60.......	1	327	0	272.5	6	374	0	311.6	39.1
61.......	2	315.5	0	262.9	6	359	0	299.1	36.2
62.......	5	197	0	164.1	6	239	0	199.1	35
63.......	5	300	0	250	6	329	0	274.1	24.1
64.......	5	333	0	277.5	6	360	0	300	22.5
65.......	4	214	0	178.3	6	240	0	200	21.7
66.......	5	231.5	0	192.9	7	255	0	212.5	19.6
67.......	6	266	14	221.6	6	289	11	240.8	19.2
68.......	1	341	0	284.1	7	363	0	302.5	18.4
69.......	2	231	0	192.5	6	249	0	207.5	15
70.......	1	248	0	206.6	7	261.5	0	217.9	11.3
71.......	4	325	0	270.8	6	335	0	279.1	8.3
72.......	4	317	0	264.1	6	326	0	271.6	7.5
73.......	3	265	0	220.8	7	272	0	226.6	5.8
74.......	6	227	5	189.1	7	231	4	192.5	3.4
75.......	6	315	0	262.5	7	318	0	265	2.5
76.......	2	266	0	221.6	5	266	0	221.6	0
77.......	2	289	0	240.8	7	287	0	239.1	—1.7
78.......	7	338	0	281.6	7	334	0	278.3	—3.3
79.......	4	306	6.5	255	6	292	5.5	243.3	—11.7
80.......	2	295	0	245.8	7	275	0	229.1	—16.7
81.......	4	351	0	292.5	6	324	0	270	—22.5
82.......	2	235	0	195.8	7	182.5	0	152.1	—43.7

Average yield of rows sprayed only by owner, 230.25 *bu. per acre.*
Average yield of rows sprayed also by the Station, 244 *bu. per acre.*
Average increase in yield per acre, 13.75 *bu. or* 5.5 *per ct.*

COMMENTS ON THE RESULTS.

The results are difficult to interpret. They are extraordinary. The increase in yield was smaller than it was in 1913 when the conditions were, apparently, much less favorable. Of course, spraying can not be expected to produce a large increase in yield in a season in which potato foliage is so free from diseases of all kinds as it was at Rush in 1914. But the writer's previous experience has led him to believe that with such thorough spraying a considerable increase in yield is to be expected under any and all conditions provided the season is long enough for the plants to complete their growth. In the absence of disease it is the stimulation of the bordeaux which brings about the increase in yield by prolonging the life of the plants. Hence, the beneficial influence of bordeaux is likely to be most marked in a long growing season.

In several of the experiments the unsprayed row outyielded the sprayed row. The same thing happened in 1913 and the explanation of it was discussed at some length in Bulletin 379. At present it is sufficient to say that this is to be ascribed to original inequality between the two test rows rather than to any injurious action of the bordeaux. It shows how great is the chance of error in experiments of this kind.

The results of the experiments at Rush during the past two years can not be expected to encourage the practise of spraying potatoes. Proof that spraying is profitable must be sought in the results of other experiments of which there is an abundance.* As has often been said, spraying is a form of insurance. Although unprofitable in certain years it is highly profitable on the average.

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* See Bulletin 349 of this Station.

ASCOCHYTA CLEMATIDINA, THE CAUSE OF STEM-ROT AND LEAF-SPOT OF CLEMATIS.* †

W. O. GLOYER.

SUMMARY.

(1) The stem-rot and leaf-spot of clematis are caused by the fungus *Ascochyta clematidina* (Thümen).

(2) The plants are killed by the growth of the fungus down the petiole into the stems, thus girdling the plant at the node. The stem may be girdled also by the lesions anywhere on the internodes. Dead stubs left on the vines are a means of holding the disease over a period of time. New shoots may be formed below the girdled region, but the downward progress of the fungus ultimately kills the plant if the diseased tissue is not removed.

(3) Overwintering out of doors does not kill the fungus in cultures or on dead vines. Whenever the temperature permits, the fungus resumes its growth.

(4) The fungus is readily isolated and grows well on the media generally employed in the laboratory.

(5) The disease has been successfully produced by inoculating *C. paniculata* and *C. jackmanni* with the mycelium from pure cultures. The fungus has been reisolated from such inoculations, and with it lesions were again produced on other vines similarly treated.

(6) *A. clematidina* is not related to other common species of the genus Ascochyta, for inoculations made in growing stems of bean, pea, muskmelon, pumpkin, eggplant, and the young shoots of elm gave negative results.

(7) Spraying the plants with spores will produce the leaf-spot. More spots are produced when the spores are placed on the lower surface of the leaf than on the upper. A temperature of 23° C. is more favorable for the production of the leaf-spot than a temperature of 10° C.

(8) The matting of the vines produces a condition most favorable for the spread of the disease. Ventilation can be obtained by supporting the vines or by planting them far enough apart to prevent matting.

(9) On the hybrids the disease can be controlled in the forcing frames or in the greenhouse by the use of sprays. In the field, the spraying of hybrids properly supported is of little benefit.

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* Also printed in *Journal of Agricultural Research*, 4: 331-342. 1915.

† A reprint of Technical Bulletin No. 44, August, 1915.

(10) On *C. paniculata* spraying with a fungicide checks the disease. In the field the removal of diseased leaves and vines before spraying is of practical value in controlling the disease.

(11) Sulphur dusted on *C. paniculata* in large quantities may cause injury.

(12) A mixture of 1 pound of laundry soap and 6 pounds of sulphur to 15 gallons of water, when sprayed on cuttings in the greenhouse or on *C. paniculata* growing in the beds, controlled the disease.

INTRODUCTION.

The sudden dying of clematis plants has been known for many years, and there has been much speculation as to its cause and prevention. Apparently the disease occurs in both Europe and America wherever the large-flowered kinds of clematis are grown extensively. From published accounts it is clear that the various writers had in mind the same disease, though they ascribed it to different causes. In 1884 Arthur (1)[1] studied a clematis stem-rot which he suspected of being due to the fungus *Phoma clematidis* Sacc. Trelease (16), Comstock (3), Klebahn (7), and others have considered nematodes as the causal agent. In specimens received from Klebahn, Ritzema Bos (2) found nonparasitic nematodes, while in material of his own collection he found the larvæ of a fly, *Phytomyza affinis*, and a species of Pleospora. Prillieux and Delacroix (9) and Morel (8) believed the disease to be of bacterial origin. Sorauer (13) reports a gall-like formation on the stem of *Clematis jackmanni* near the surface of the soil and attributes the death of the affected plants to *Gloeosporium clematidis*. Green (5, p. 284–285) has reported the relative susceptibility of a few varieties of clematis which he grew, but he did not attempt to ascertain the cause of the disease. Except for a preliminary abstract by the writer (4), the primary cause of the clematis disease has heretofore been unknown.

DESCRIPTION OF THE DISEASE.

The clematis disease manifests itself differently on the various species and hybrids. On hybrids grown in the field it is a stem-rot, while in the greenhouse, where the cuttings are propagated, it is a leaf-spot as well as a stem-rot. On *Clematis paniculata* the disease takes both forms.

C. paniculata, a type species, is propagated from seed[2] and when grown in uninfected cold frames or greenhouses remains free from disease. Such seedlings are either potted or placed in beds, where they are planted about an inch apart in rows 4 inches apart. In the fall, when these plants have made a growth of 8 to 10 inches, the leaf-spot may make its appearance and be thus carried over the winter on the dead leaves or in lesions formed on the vines. If these plants are left in the beds a second season, the fungus may make its appearance early in spring and increase until by midsummer no vine is wholly free from disease. The leaf-spot may first appear either as a mere dot or as a water-soaked area. With the advent of moist warm weather the former usually leads to the latter. On drying the water-soaked spot becomes tan-colored with a red margin. Plate XVIII shows the general appearance of the disease on *C. paniculata*. The older leaves are badly diseased or dead, and the fungus has grown down the petiole to the node, where in time the vine may become girdled. The younger leaves show the early stages of the leaf-spot. The stem shows the lesions, reddish in color, formed at the nodes and on the internodes. Later these take on a gray color. Plate XIX illustrates a group of leaves of *C. paniculata* with spots that are zonate, owing to the unequal growth of the fungus under the influence of changes in temperature. The newly formed spot has a dark margin of red tissue and a lighter center. Pycnidia are produced on the diseased leaves. Succulent, growing tissues succumb more readily to the disease than do the woody stems. In the latter it may require a month for the fungus to pass a node. Plate XX, fig. 1, shows a portion of a vine of *C. paniculata* 44 inches long on which the lower leaves were wilted, while the distal ones were still turgid. The fungus entered through the stub *a*. It girdled the stem and disintegrated the upper roots, leaving the central cylinder as the only means of communication with the healthy roots below. Pure cultures of *Asocochyta clematidina* were obtained from the boundaries of the lesion. Pycnidia were formed on the stem above the ground. In other cases pycnidia have been found on the epidermis, while the tissues underneath were healthy.

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[1] Reference is made by number to "Literature cited," p. 329.

[2] For description of general methods of propagation and of the various species of clematis see the following:

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Some of the large-flowered kinds of clematis are grown from seed, but in America the majority of those cultivated are hybrids. They are propagated from cuttings taken from rapid-growing, disease-free vines. The cuttings are made in May or June and consist of a single node with the attached leaves and the internode below. They are placed in moist sand and exposed to bottom heat or else grown in forcing frames. In clematis forcing frames the humidity and temperature are usually higher than in the average greenhouse. Under these conditions, if the spores are present, a leaf-spot may be formed, and the entire cutting may be killed or the fungus may be halted at the node. The fungus that has been checked may again become active when the cuttings are potted and placed in the greenhouse, or new infections may take place on the leaves. In the fall some of the plants are placed in storage, while others are kept over winter in the greenhouse and the tops used for cuttings. In the following spring both lots are transplanted into the open field and, unlike *C. paniculata*, are not allowed to trail on the ground. Experience has taught the nurseryman that supported vines, owing to the better ventilation they receive, do not die as readily as those left on the ground. They make a vigorous growth, and yet when about to bloom they may suddenly die. It is at this stage that the disease first attracts the attention of the nurseryman, though in reality it was on the plants while they were still in the greenhouse and was there overlooked. Plate XX, fig. 1, shows a plant free from leaf-spot, yet girdled by the fungus lurking in the stub *a*, which in ordinary practice is not removed. Plate XX, fig. 2, is a reproduction of another vine of *C. jackmanni* that has many pycnidia of *A. clematidina* on the old stub. After the removal of this stub some of the discolored tissue still remained. The new shoot formed is wilting, and the split stem shows discolored fibrovascular bundles from which *A. clematidina* was isolated. In advanced stages the roots may disintegrate similarly to that shown in Plate XIX, fig. 1. The spots on the leaves of *C. jackmanni* resemble those found on *C. paniculata*, *C. recta*, and *C. virginiana*.

ISOLATION OF THE CAUSAL FUNGUS.

By previous writers the dying of clematis plants has been assigned to various factors, but none have discovered the primary cause. The dying of the leaves owing to lack of light, the breaking of the vine by strong winds, and injury by nematodes are factors that have been eliminated as primary agencies, while the constant association of *A. clematidina* points to it as the causal organism. The fungus can be readily isolated by the poured-plate method, using the spores from a crushed pycnidium, by the use of sterile leaf tissues, or by the use of free-hand sections of diseased material. The last-named method consists in making free-hand sections under as sterile conditions as possible by sterilizing the outer tissue and the instruments. If such sections show mycelium they are transferred to sterile media. Some have maintained that no mycelium can be seen in the decayed tissue, but the writer has observed in the tissues 3 to 5 mm. from the boundaries of the lesions mycelium which in plate cultures proved to be that of the causal organism, *A. clematidina*.

A. clematidina grows well on the media generally used in the laboratory. It grows at about the same rate on nutrient glucose agar, oatmeal agar, bean pods or stems, moist oats, and corn meal, producing pycnidia in five to seven days. These pycnidia may show a pink tinge at first and later turn brown. The fungus grows less vigorously on corn-meal agar, potato agar, starch agar, sugar-beet plugs, apple twigs, and sterile raw carrot. Oatmeal and starch agar are at first turned green, but later take on a brown color. On starch agar the mycelium penetrates the medium and forms chlamydospores, as shown in Plate XIX, fig. 1. These are thick-walled, green-brown bodies filled with oil globules. When placed in water, they germinate readily.

INOCULATION EXPERIMENTS.

To prove the pathogenicity of *A. clematidina*, mycelium from pure cultures was inoculated into stems of *C. paniculata* and *C. jackmanni*. In all cases lesions were produced, while the checks remained normal. From such lesions the fungus was reisolated, and, when again inoculated into either host, typical lesions were produced. In all, four sets of inoculation experiments were carried out at various times, making from 3 to 10 inoculations on each of 32 plants. Inoculations on succulent stems caused the vines to wilt in four days, while in one case an inoculation on a woody vine 6 mm. in diameter required 47 days to kill the plant. Pycnidia were produced on all lesions.

Plants of *C. paniculata* were sprayed with sterile water containing spores of *A. clematidina* and then kept under bell jars for two days. on the third day the leaves showed water-soaked spots of various sizes, while the checks, which had been sprayed with sterile water, remained free from disease. To test the effect of temperature on infection, two plants were sprayed with the same spore-laden water and then subjected to different temperatures—23° C. and 10° C. At the end of five days the plant kept at 23° showed 45 leaf spots, while the plant kept at 10° showed but 1 spot.

Spores placed on the lower surface of the leaves produced more spots than those placed on the upper surface. Typical lesions were also produced on the roots by inoculating them with the mycelium from a pure culture.

The *A. clematidina* isolated from *C. paniculata* was inoculated into growing stems of bean, pea, muskmelon, pumpkin; into stems, petioles, and fruits of eggplant (var. Black Beauty); and into the young shoots of elm. In all cases negative results were obtained. On most of these plants pycnidia were produced on the tissues killed in making the wound, but in no case did the mycelium penetrate the healthy tissues and form a lesion.

TAXONOMY OF THE FUNGUS.

Arthur (1) observed a species of Phoma, possibly *P. clematidis*, on clematis, but on consulting the original notes made by him it is clear that he had a fungus different from that found by the writer. On but one occasion has *Phoma* sp. been found and that was a saprophyte on the leaf of *C. paniculata*. It was isolated in pure culture, the mycelium inoculated into the stems, and the spores sprayed on leaves, but in no case were lesions or leaf-spots produced.

Saccardo (11) notes *A. clematidina*, *A. vitalbae*, *A. indusiata*, and *A. davidiana* as occurring on various species of clematis, and their chief point of difference is in the size of the spores. The writer has examined the specimens of *A. clematidina* Thümen on *C. virginiana* collected by Mr. J. J. Davis in Wisconsin and distributed in Fungi Columbiani No. 2503; also those of *A. indusiata* Bres. on *C. recta* in Krieger's Fungi Saxonici No. 1189. In both, the spots resemble those found on *C. paniculata* and *C. jackmanni*. In the former the spores are cylindrical 1-septate and hyaline. They measure 8 to 12 by 3.2μ, the average dimensions being 9.5 by 3.2μ. The spores of the latter species are hyaline to honey-colored, somewhat constricted, and measure 12 to 22 by 6.3μ, with an average of 19 by 6μ.

The writer has repeatedly examined the species of Ascochyta on clematis and found it quite variable. The chief difference is in the spores, though sometimes the pycnidia are more deeply immersed than at other times. Plate XXI, fig. 1, shows a pycnidium in the leaf tissues of *C. paniculata*. The spores vary in length from 6 to 28μ and in width from 3 to 6μ, but generally they are about 9 to 13 by 3 to 4μ. Plate XIX, fig. 3, shows the typical spores. The spores are either 1- or 2-celled, rarely 3-celled. Some leaves of *C. jackmanni* collected in the fall of 1914 showed pycnidia having spores as long as 28μ and averaging 18 by 5.7μ. Inoculations with material from cultures obtained by the isolation of single spores showed that this fungus was the same as that usually encountered. The various differences in color shown by the spores disappear when the spores are plated out under control conditions. Considering the variability of the fungus found by the writer, any of the descriptions given for the different species of Ascochyta described on clematis would in general apply to it. Hence, the name selected is the oldest one, *Ascochyta clematidina* Thümen, the description of which is here emended as follows:

Ascochyta clematidina (Thümen).

Ascochyta clematidina Thümen, Pilzfl. Sibir. n. 619, 1884, *in* Sacc. Syll. Fung., v. 3, p. 396.

On stems and foliage; spots circular, zonate to indefinite; pycnidia (on leaves mostly epigenous, sometimes hypogenous) tan to dark brown, scattered to gregarious, globose to subovoid, immersed, then erumpent, ostiolate, averaging 120μ in diameter; spores variable, subellipsoidal to cylindrical, 1- or 2-celled, septa more or less medial, sometimes constricted, hyaline to dilute honey or olive color, often guttulate, 6 to 28 by 3 to 6.4μ, usually 9 to 13 by 3 to 4μ; exuded spore mass honey-colored, sometimes pink.

On living leaves and stems of *Clematis paniculata*, *C. virginiana*, and the hybrids *C. hendersoni*, *C. henryi*, *C. jackmanni*, *C. ramona*, *C. Duchess of Edinburg*, *C. Mme. Baron Veillard*, and *C. Mad. Edouard André*. According to Von Thümen, it occurs also on living leaves of *C. glauca*. As yet no perfect form of *A. clematidina* has positively been found.

CONTROL EXPERIMENTS IN 1913.

In 1913 some 2-year-old plants of *C. paniculata* that had made a dense, matted growth of tangled vines were badly diseased, while a bed of seedlings next to them was free from disease. In an attempt to save the 2-year-old plants, they were cut back to a length of 4 to 6 inches and then sprayed with bordeaux mixture on July 21. A small area was left unpruned and unsprayed as a check. By October 17 the seedlings, which had made a growth of 8 to 10 inches, showed an occasional leaf spot. The pruned-and-sprayed plat produced an excellent growth, but had some leaf-spot and a few girdled vines. The check showed many dead plants, and none of the living ones were entirely free from disease.

CONTROL EXPERIMENTS IN 1914.

A writer in *Garden* (10) states that bordeaux mixture, when applied to diseased clematis plants, was of no benefit in checking the disease. In 1914, spraying experiments were carried out by the writer on 18 rows (about 300 feet long) of plants of *C. jackmanni*, half of which were sprayed with bordeaux mixture (4–4–50 formula), while the others were left as checks. Four of these, two checks and two sprayed rows, were pruned on June 12 and 25 in such a manner as to remove the dead stubs of the previous year. Plants from which all of the discolored tissue could not be removed without injury to the entire vine were marked with tags. The rows receiving bordeaux mixture were sprayed every two weeks. The final examination was made on October 19. No difference could be seen between the sprayed and the check rows either in the amount of leaf spot or the number of dead plants. The same held true for the pruned and unpruned rows. However, there was but little leaf-spot, and it was observed that the dead plants in the pruned rows were invariably plants that had been tagged. No doubt the pruning was done too late in the season to be of any benefit. Sulphur dusted on cuttings in the forcing frames did not check the disease. Plants in the greenhouse sprayed with soap-and-sulphur mixture so as to cover the leaves with a thin film were healthier than the unsprayed plants. These, however, were not carried through the second season, and hence the ultimate results are unknown.

Two long, narrow beds of *C. paniculata* were utilized for spraying and dusting experiments in 1914. Bed 1 consisted of yearling plants untreated in 1913. Bed 2 contained 2-year-old plants pruned and sprayed with bordeaux mixture in 1913. Both beds were divided into plats 6 by 25 feet in size.

Two plats in each bed were sprayed with bordeaux mixture six times at intervals of two weeks from May 15 to August 8. On the same dates one plat in each bed was sprayed with a soap-and-sulphur mixture composed of 1 pound of soap, 6 pounds of sulphur, and

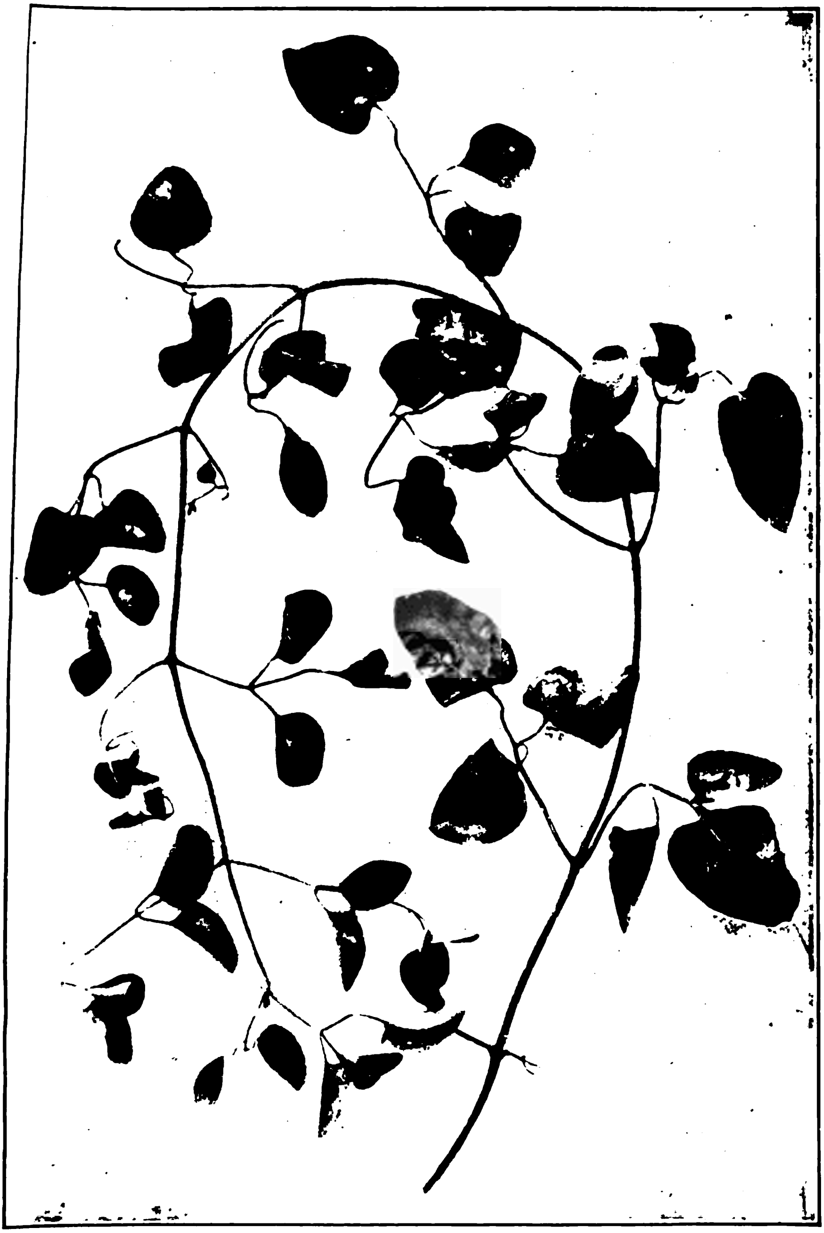

Plate XVII.— *Clematis paniculata:* Portion of Vine Showing General Nature of Leaf Spot.

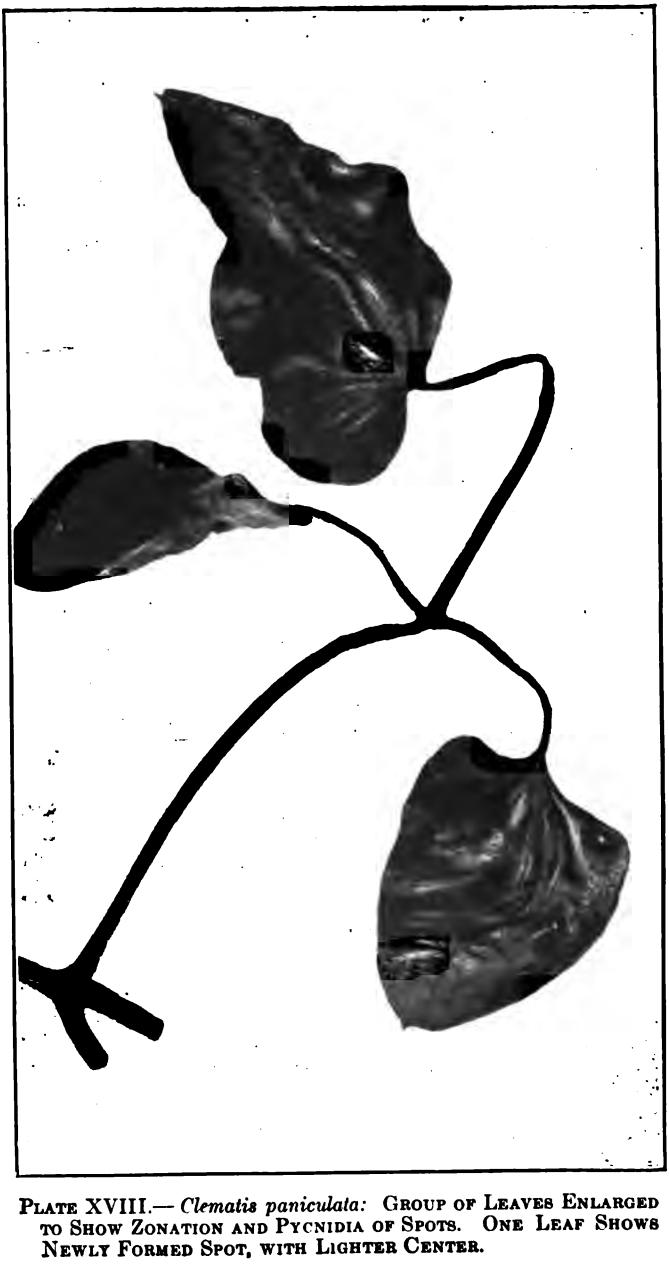

PLATE XVIII.— *Clematis paniculata:* GROUP OF LEAVES ENLARGED TO SHOW ZONATION AND PYCNIDIA OF SPOTS. ONE LEAF SHOWS NEWLY FORMED SPOT, WITH LIGHTER CENTER.

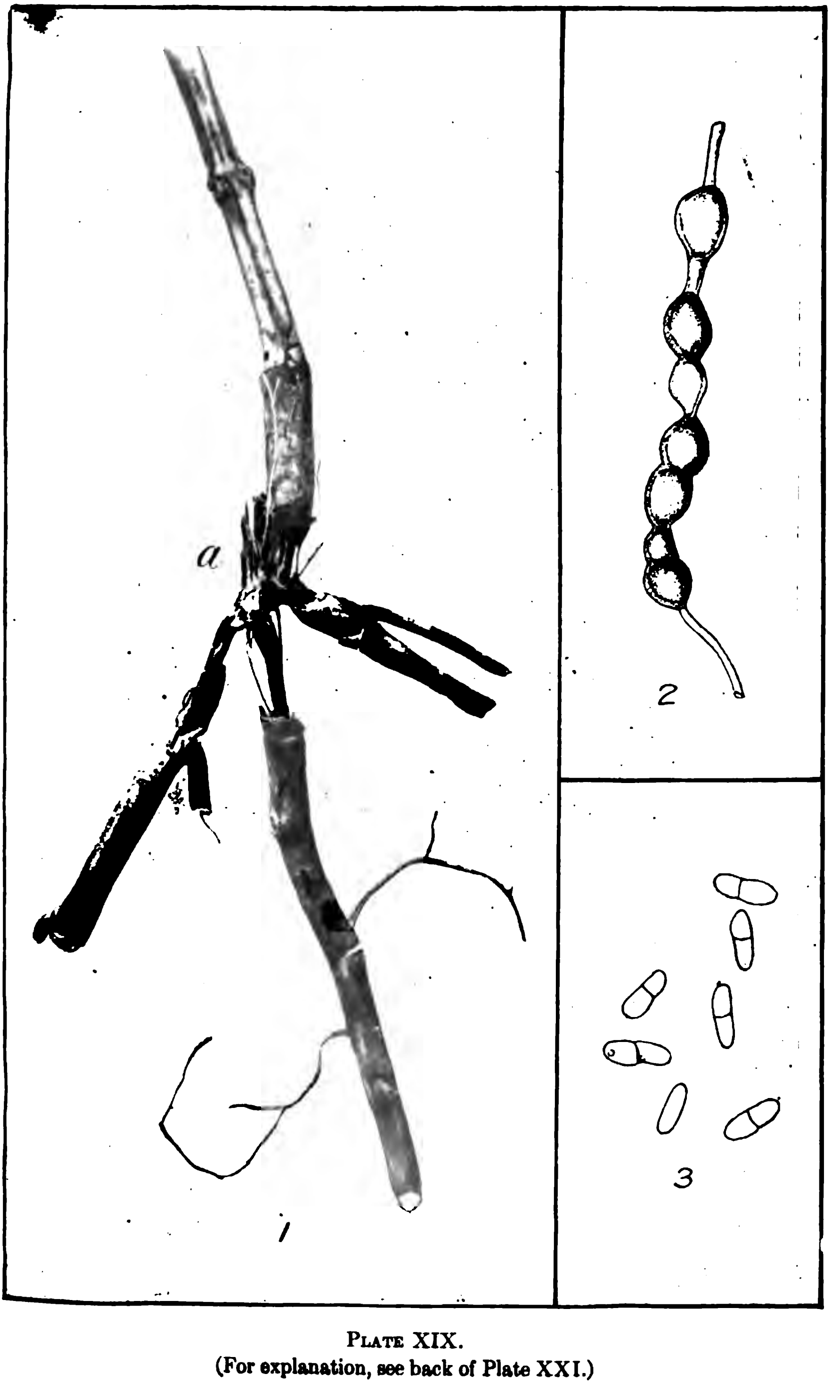

PLATE XIX.
(For explanation, see back of Plate XXI.)

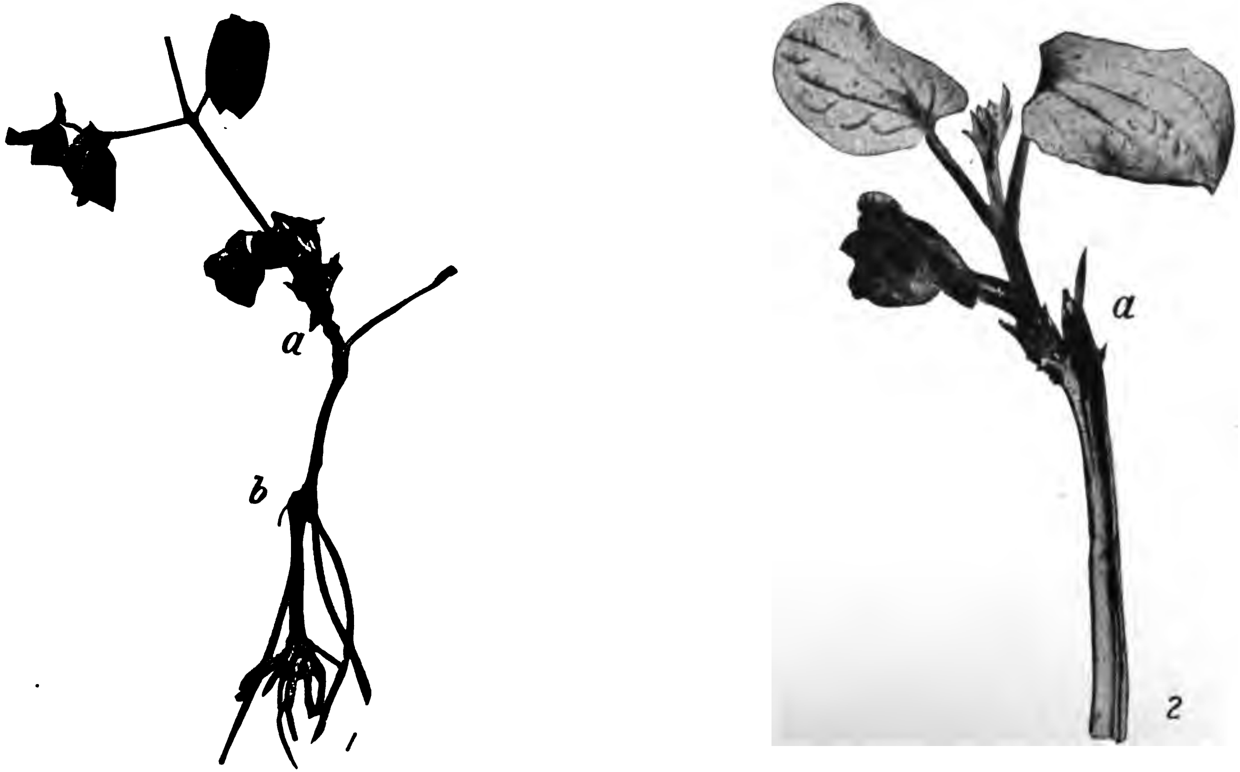

Plate XX.
(For explanation, see back of Plate XXI.)

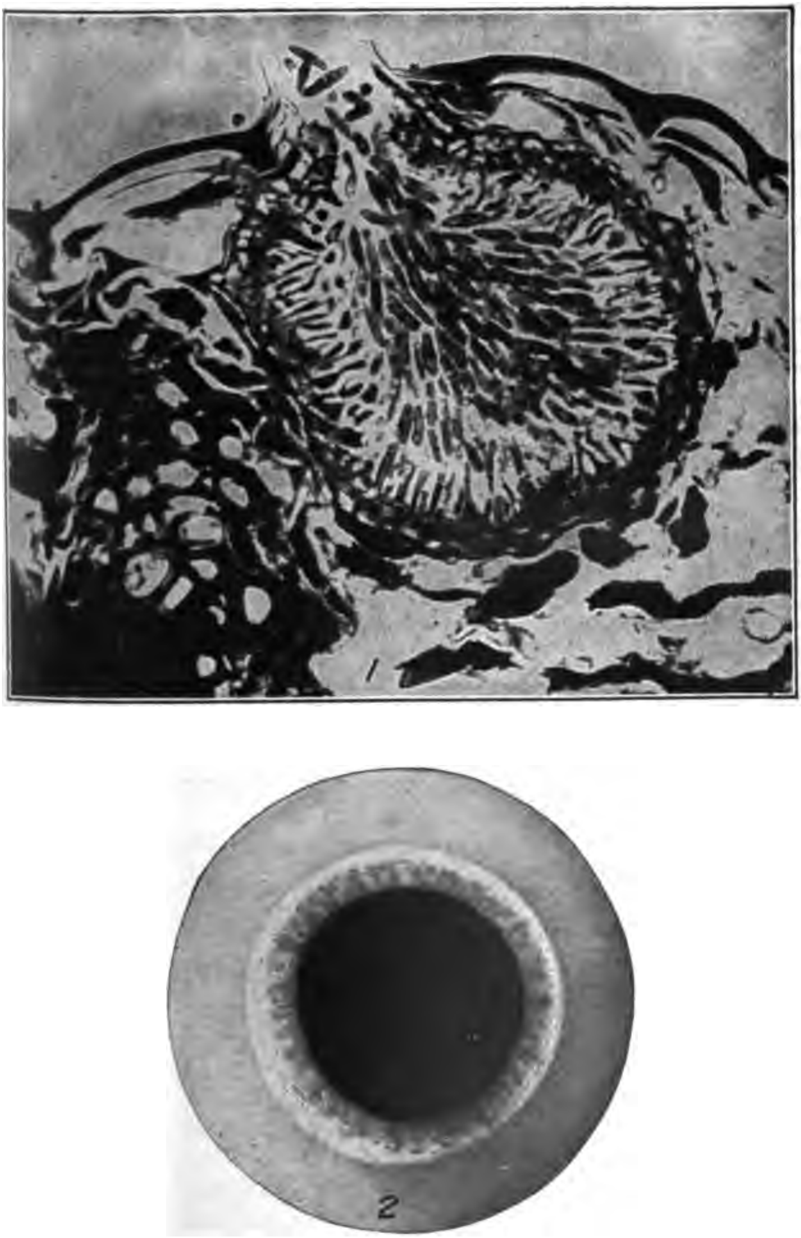

Plate XXI.
(For explanation, see back of this plate.)

EXPLANATION OF PLATES XIX, XX, AND XXI.

PLATE XIX.

Fig. 1.—*Clematis paniculata:* A portion of a vine 44 inches long that showed indications of wilting of the lower leaves while the distal leaves were still turgid. The fungus entered through the stub *a*. In the girdled region the parenchyma of the roots had disintegrated, leaving the central cylinder as the only means of communication with the healthy roots below. *Ascochyta clematidina* was isolated in pure cultures from the boundaries of the lesion.

Fig. 2.—*Ascochyta clematidina:* Chlamydospores as formed on starch agar.

Fig. 3.—*Ascochyta clematidina:* Camera-lucida drawing of spores.

PLATE XX.

Fig. 1.—*Clematis jackmanni:* A vine free from leaf-spot that has been girdled by *Ascochyta clematidina* in the region of the previous year's stub *a*. A new shoot would have been sent forth from an active bud at *b*, but it would have soon died, for the fungus had discolored the vascular bundles beyond this point. The presence of the fungus was proved by isolating it from the discolored tissue.

Fig. 2.—*Clematis jackmanni:* Plant from which the diseased stub *a* was cut away without removing the discolored tissue. The leaves were free from leaf-spot and were drying. The split stem shows the discolored fibrovascular bundles from which the fungus was isolated.

PLATE XXI.

Fig. 1.—*Ascochyta clematidina:* Photomicrograph of a pycnidium from stained section of a leaf of *Clematis paniculata*.

Fig. 2.—*Ascochyta clematidina:* Culture growing on agar to which Ivory soap at the rate of 1 pound to 15 gallons of water was added, showing the oily film about the margin of the culture in which the crystals of stearic acid are found.

15 gallons of water. Two and one-half gallons of the mixture, containing 1 pound of sulphur, were used on each plat at each application. On two plats in bed 1 and one plat in bed 2 the plants were dusted six times with sulphur, using 1 pound to the plat at each application. The remaining eight plats (three in bed 1 and five in bed 2) were left untreated for checks.

As the season advanced, the virulence of the disease increased, becoming quite severe on all three check plats in bed 1 and one check plat in bed 2. On August 8 some of the plats were pruned, thus terminating the main experiment. The effect of the different kinds of treatment up to August 8 is shown in Table I.

TABLE I.—RESULTS OF AN EXPERIMENT ON THE CONTROL OF LEAF-SPOT AND STEM-ROT OF *Clematis paniculata*.

Bed No. 1.			Bed No. 2.		
Plat No.	Treatment.	Percentage of plants free from disease.	Plat No.	Treatment.	Percentage of plants free from disease.
1	Bordeaux mixture.....	75	9	Bordeaux mixture.....	60
2	Check...............	2	10	Check...............	2
3	Bordeaux mixture.....	80	11	Sulphur..............	70
4	Check...............	10	12	Check...............	45
5	Sulphur..............	80	13	Soap and sulphur......	100
6	Soap and sulphur......	100	14	Check...............	85
7	Check...............	10	15	do	85
8	Sulphur..............	65	16	do	85
			17	Bordeaux mixture.....	95

The results are more uniform in bed 1 than in bed 2. This may be due to the treatment of bed 2 the previous year. That there was more disease in plats 9 and 10 than in the other plats of bed 2 may be accounted for by the fact that these two plats were used as checks in 1913, and hence were neither pruned nor sprayed in that year. Plats sprayed with the soap-and-sulphur mixture remained free from leaf-spot and lesions on the stems; hence, their condition is rated at 100 per ct. In rating the other plats the amount of leaf-spot, the number of lesions, and number of girdled plants have all been considered.

On the plats 1, 3, and 17, which were sprayed with bordeaux mixture and which were not pruned on August 8, the spraying was continued to the end of the season. Check plats 4, 14, and 16 also were left unpruned. On October 19, when the final examination of these plats was made, it was found that in plats 1 and 3 the leaves on the new growth were disease-free and that there was but an occasional dead vine. On check plat 4 half of the newly formed leaves were diseased, and about one-third of the vines were dead. Plats 16 and 17 showed about the same amount of leaf-spot, only an occasional spot. The former, however, showed more lesions on the stems than the latter. Check plats 2, 7, 10, and 12, which had been pruned back to a length of 4 to 6 inches and then given one application of bordeaux mixture, had but little disease as compared with plat 4, which had received no treatment whatsoever.

INJURIOUS EFFECTS OF SULPHUR ON CLEMATIS PANICULATA.

The promising results obtained by Smith (12) in dusting asparagus with sulphur for the control of rust led the writer to try sulphur in controlling the fungus on clematis. Up to August 8 the results were satisfactory, and no injury was observed. Soon after the pruning of August 8 there were several hot, dry days followed by a period of rainy weather, during which water accumulated at the end of bed 1. Up to the end of the season only one plant in plat 8 had sent forth a new shoot. The other vines were dead, and the stems at the surface of the ground for about an inch were discolored. A particle of soil placed on the tongue had an acid taste. According to a test made by Mr. R. F. Keeler, 1 gm. of this soil is equivalent to 0.5 c.c. of $\frac{N}{10}$ acid, while soil from the adjoining check plat 7 was neutral. In check plat 7 a few vines died, owing to the lack of drainage, but it seems apparent that in the other cases the injury was caused by sulphur that had washed from the foliage and had accumulated in the upper layer of soil. As the season advanced, sulphur injury was observed in the other treated plats, but in these cases the injury was localized in areas not larger than 2 feet in diameter. The injury began to show on the plats sprayed with the soap-and-sulphur mixture after nine applications had been made, while in the plats dusted with sulphur it appeared after six applications had been made.

SOAP AND SULPHUR AS A SPRAY MIXTURE.

A mixture of about 1 pound of laundry soap and 6 pounds of sulphur in 15 gallons of water was in common use as a greenhouse spray at the nursery where the spraying experiments were conducted. It was used with success in the control of leaf-blotch, *Diplocarpon rosae* Wolf, on susceptible varieties of roses grown in the forcing houses. Halsted and Kelsey (6) used Ivory soap at the rate of 1 ounce to

4 gallons of water for spraying *Phlox drummondii* and the common verbena attacked by powdery mildew and were able to check it. Another (15) has shown that soap at the rate of 1 ounce to 1 gallon of water controlled the mildew and aphids of roses. R. E. Smith (12) recommended that, in the absence of dew, whale-oil soap be sprayed on asparagus tops to hold the sulphur that is to be dusted over them for the control of the rust. Spieckermann (14) has shown that weak solutions of soap have a nutritive value and can be assimilated by the higher fungi.

In order to test the toxic effect of soap, mycelium of *A. clematidina* was transferred to petri dishes containing soap agar of different strengths — viz, 2 per ct. agar containing alkali-free Ivory soap in the proportion of 1 pound to 5, 10, 15, 20, and 40 gallons of the medium. Fifteen c.c. of such media were placed in each petri dish. When the fungus became established, the diameter of the culture was measured daily, and the rate of growth was considered as a measurement for toxicity. Cultures on 2 per ct. agar and nutrient-glucose agar served as checks. Table II gives the averages of growth of four or five cultures on each medium grown under the same conditions at room temperature.

TABLE II.—SUMMARY OF THE DATA ON THE TOXIC EFFECT OF SOAP AGAR OF VARIOUS STRENGTHS ON *Ascochyta clematidina*.

Culture medium.	Number of cultures.	Average diameter of cultures after growth for—									
		3 days.	5 days.	7 days.	9 days.	11 days.	13 days.	15 days.	17 days.	20 days.	23 days.
		Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
Soap agar (1 lb. to 5 gals.)	5	0	0	0	0	0	0	0	0	0	0
Soap agar (1 lb. to 10 gals.)	5	0	0	0	0	0	0	0	0	0	0
Soap agar (1 lb. to 15 gals.)	4	0	7	9	11	15	18	20	22	25	28
Soap agar (1 lb. to 20 gals.)	5	0	11	15	19	23	26	30	34	39	44
Soap agar (1 lb. to 40 gals.)	4	8	20	25	32	40	44	50	56	67	73
Check, 2 per cent agar	5	10	21	29	40	51	61	70	77	85	....
Check, nutrient-glucose agar	5	15	29	38	48	60	69	77	...	...	....

Plate XXI, fig. 2, shows a culture of *A. clematidina* on soap agar. The concentric ring or oily film about the culture may be 2 to 7 mm. wide. Upon the drying of the medium, crystals of stearic acid are seen only in this region, indicating that an active principle given off by the fungus liberated the fatty acid. The culture shows a green discoloration, which is due to the formation of brown-green, thick-walled chlamydospores. These bodies, as well as the mycelium, are filled with oil globules, while none are found in the 2 per ct. agar. These cultural experiments indicate that soap at the strengths in which it is used as a contact insecticide has in itself fungicidal value, as well as being a means of adhesion or suspension for other materials.

METHODS OF CONTROLLING THE FUNGUS.

The suggestions here given for controlling *A. clematidina* are based upon the observations and experiments made in the last three years. Greater success can be attained by changing the methods of culture than by spraying. Long experience has taught the nurseryman that there is less disease when the hybrids are supported while growing in the field or in the greenhouse than when they are permitted to trail on the ground. This holds true also for *C. paniculata*, but its selling price does not warrant so much expense for labor. This can be overcome by transplanting the plants from the beds to the open field after the first year, placing them far enough apart to prevent matting. Spraying is beneficial to such plants, but before making such applications it is advisable to remove all diseased leaves and dead vines. Plants so treated are disease-free in the fall. If seedlings are grown in a greenhouse where clematis has never been grown before and are kept away from older diseased beds, they will remain disease-free. The fungus can live as a saprophyte on dead vines kept out of doors in baskets, and under such conditions it has lived over two winters, producing pycnidia and viable spores in abundance. This indicates that the same beds should not be used for clematis in successive years.

On hybrids the disease is primarily a greenhouse trouble and can be overcome by the use of cuttings made from healthy plants. A light spraying with the soap-and-sulphur mixture has proved satisfactory in the greenhouse. It could readily be applied also in the forcing frames. Diseased leaves or stubs should be removed as soon as discovered so as to prevent the fungus becoming established in the tissues.

The retail purchaser of clematis can prevent the dying of plants by taking proper simple precautions. The plants should be placed in good soil, well drained and on a sunny exposure. As soon as the new shoots have formed the old vine tissue should be carefully cut away close to the new shoots, removing all traces of the brown, discolored wood in which the fungus is to be found. Proper ventilation is obtained by training the plants to a strong trellis.

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REPORT

OF THE

Department of Chemistry.

L. L. Van Slyke, *Chemist.*
[1] Alfred W. Bosworth, *Associate Chemist.*
Rudolph J. Anderson, *Associate Chemist.*
Arthur W. Clark, *Associate Chemist.*
Morgan P. Sweeney, *Assistant Chemist.*
Otto McCreary, *Assistant Chemist.*
[2] Richard F. Keeler, *Assistant Chemist.*
[3] William F. Walsh, *Assistant Chemist.*
[3] Arthur J. Flume, *Assistant Chemist.*

TABLE OF CONTENTS.

I. Concerning the organic phosphorus compound of wheat bran, and the hydrolysis of phytin.
II. Fibrin.
III. Human milk.
IV. The casein and salts of goat's milk.

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[1] Resigned December 31.
[2] Transferred from Department of Agronomy, November 1.
[3] Appointed March 22.

REPORT OF THE DEPARTMENT OF CHEMISTRY.

CONCERNING THE ORGANIC PHOSPHORUS COMPOUND OF WHEAT BRAN AND THE HYDROLYSIS OF PHYTIN.*

R. J. ANDERSON

SUMMARY.

This bulletin contains reports of investigations concerning: (I) the nature and composition of the principal organic phosphoric acid isolated from the 0.2 per ct. hydrochloric acid extract of wheat bran, (II) the products formed from phytin by the action of the enzyme phytase contained in wheat bran, (III) the hydrolysis of the organic phosphorus compound of wheat bran in different solvents and (IV) the nature and composition of the organic phosphorus compound of wheat bran when isolated from solvents which destroy the enzyme phytase.

It has been shown in previous reports that the organic phosphorus compounds isolated from 0.2 per ct. hydrochloric acid extracts of wheat bran differ in composition from phytin and phytic acid or inosite hexaphosphoric acid. (Technical Bulletin No. 22 of this Station.)

It has also been shown that the above substance is not a homogeneous compound but that it can be separated into several fractions which differ in composition. (Technical Bulletin No. 36 of this Station.)

I. The first part of this bulletin describes the further separation of these compounds and the isolation of a new organic phosphoric acid, inosite triphosphoric acid, as a crystalline strychnine salt from the water-insoluble portion of the acid barium salts.

The neutral barium inosite triphosphate, $C_6H_9O_{15}P_3Ba_3$, was prepared from the crystalline strychnine salt. It was a white amorphous powder.

The free inosite triphosphoric acid $C_6H_{15}O_{15}P_3$, was prepared from the barium salt and it was obtained as a non-crystallizable syrup.

The reactions of inosite triphosphoric acid differ in several particulars from those of phytic acid or inosite hexaphosphoric acid but like the latter it decomposes when heated in a sealed tube with dilute sulphuric acid into inosite and phosphoric acid.

II. The chief products of the hydrolysis of phytin by the phytase in wheat bran are inorganic phosphoric acid and certain intermediate compounds apparently consisting of inosite tri-, di- and monophosphoric acids. These intermediate substances are identical with the compounds which we have previously isolated from 0.2 per ct. hydrochloric acid extracts of wheat bran.

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* A reprint of Technical Bulletin No. 40, January, 1915.

A portion of the phytin was completely hydrolyzed by the action of the enzyme into phosphoric acid and inosite because the solution was found to contain some free inosite.

All of the phytin was partially hydrolyzed since the final reaction mixture did not contain any unchanged inosite hexaphosphoric acid.

III. The results herein reported amplify and confirm the experiments of Suzuki, Yoshimura and Takaishi and of Plimmer concerning the presence of the enzyme "phytase" in wheat bran which is capable of hydrolyzing phytin with the production of inorganic phosphoric acid.

The maximum activity of the enzyme has been shown to occur in the presence of 0.1 per ct. hydrochloric acid and 0.2 per ct. acetic acid. With increasing concentration of the hydrochloric acid the activity rapidly diminishes and with 0.5 per ct. hydrochloric acid there is practically no hydrolysis of the organic phosphorus.

The enzyme is destroyed by boiling water and by boiling 0.2 per ct. hydrochloric acid. It is also destroyed by a short exposure to 0.5 per ct. hydrochloric acid and to 0.25 per ct. ammonia.

It is shown that wheat bran normally contains about 0.1 per ct. of inorganic phosphorus, which is equal to about 11 per ct. of the total soluble phosphorus.

IV. By digesting wheat bran in 1.0 per ct. hydrochloric acid, which is sufficiently strong to destroy the enzyme phytase, it is possible to isolate from the extract crystalline barium salts of the following composition:

$$C_6H_{12}O_{24}P_6Ba_3+8H_2O \text{ and } (C_6H_{11}O_{24}P_6)_2Ba_7+14H_2O$$

These salts are identical with the tribarium phytate and heptabarium phytate obtained from oats, corn, cottonseed meal and commercial phytin. All of these materials contain therefore the same organic phosphorus compound, viz., phytic acid or inosite hexaphosphoric acid, $C_6H_{18}O_{24}P_6$.

I. INOSITE TRIPHOSPHORIC ACID IN WHEAT BRAN.*

(Eleventh paper on Phytin.)

INTRODUCTION.

The only definitely homogeneous organic phosphoric acid ever isolated from wheat bran, so far as we are aware, is the crystalline inosite monophosphate which we described in a previous paper.[1] This substance differs from other inosite phosphoric acids in that it crystallizes readily and particularly in that its barium salt is very soluble in water, i. e., it is not precipitable with barium hydroxide.

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*The experimental work herein reported was carried out mainly in the First Chemical Institute of the University of Berlin, Berlin, Germany.

[1] *Jour. Biol. Chem.* 18:441, 1914; and N. Y. Agr. Exp. Sta. Tech. Bull. 36, 1914.

Wheat bran, however, contains other organic phosphoric acids which are precipitated by barium hydroxide. It is evident from the work which we last reported[2] that this water-insoluble barium salt is not a homogeneous substance but that it is a mixture of various organic phosphoric acids. Patten and Hart[3] isolated an acid from this mixture of the water-insoluble barium salts, which they believed to be phytic acid. We have shown,[4] however, by the analyses of numerous preparations, freed from inorganic phosphate, that the above substance differs entirely in composition from phytic acid or salts of this acid. Although we were able to separate this substance into various fractions which all differed in composition, it was impossible to obtain definitely homogeneous compounds by the method employed. The separation was the more difficult since neither the barium salts nor other salts with inorganic bases crystallized.

In our previous work on wheat bran we had always used the crude bran ordinarily sold in the market for cattle feed. This product was not a pure bran but contained various impurities. It is not unlikely that these impurities also contained organic phosphoric acids which would render the separation of pure compounds from the final mixture more difficult.

In the work reported in this paper we have used a perfectly pure wheat bran which was especially prepared from winter wheat for us in a local mill.

From this pure bran the organic phosphoric acids were isolated as barium salts in the usual way (see Experimental Part). The acid barium salt finally obtained was shaken up with cold water in which about one-half of the total substance dissolved. *The examination of the water-insoluble portion forms the subject of this paper.* We hope, later on, to be able to separate the *water-soluble* substance, also, into its constituents.

The portion insoluble in water, as was shown in our last report,[5] contains a higher percentage of phosphorus and a lower percentage of carbon than the water-soluble substance.

Since the barium salt of the above organic phosphoric acid as well as salts with other inorganic bases do not crystallize we tried to prepare salts with organic bases in the hope of obtaining crystalline compounds. It was found, however, that salts with phenylhydrazin, hydrazin hydrate, aniline, pyridine, etc., showed no more tendency to crystallize than those with inorganic bases; and the brucine salt is too soluble to crystallize well.

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[2] *Jour. Biol. Chem.* 18:425, 1914; and N. Y. Agr. Exp. Sta. Tech. Bull. 36, 1914.

[3] *Amer. Chem. Jour.* 31:566, 1904.

[4] *Jour. Biol. Chem.* 12:447, 1912; 18:425, 1914; and N. Y. Agr. Exp. Sta. Tech. Bull. 22, 1912, and Tech. Bull. 36, 1914.

[5] *Jour. Biol. Chem.* 18:425, 1914; and N. Y. Agric. Exp. Sta. Tech. Bull. 36, 1914.

It was found finally that strychnine gave a readily crystalline salt with the above acid. This strychnine salt separates from the hot aqueous solution, on cooling, in long needle-shaped crystals or sometimes in large thin plates, depending upon the concentration. The salt was then purified by recrystallizing several times from water.

This substance had practically the same composition and melting point as the salts described by Clarke[6] which he had prepared from wild Indian mustard.

However, it must be noted that the molecular weight of such strychnine salts is so high that it is impossible accurately to determine the composition of the acid from the analysis of these compounds. We have used the strychnine salts therefore merely as a means of purification. After recrystallizing the salt several times the strychnine was removed and the acid again precipitated with barium hydroxide.

The substance was then analyzed and the composition agreed very closely with a neutral barium salt of inosite triphosphate, $C_6H_9O_{15}P_3Ba_3$. An acid barium salt was prepared by precipitating the hydrochloric acid solution of the neutral salt with alcohol. On analysis results were obtained which agreed with a compound of the composition $C_{18}H_{35}O_{45}P_9Ba_5$, which apparently represents three molecules of monobarium inosite triphosphate joined by two atoms of barium.

The free acid was prepared from the barium salt and analyzed. The results agreed closely with the calculated composition of inosite triphosphoric acid, $C_6H_{15}O_{15}P_3$.

Unfortunately the barium salts were obtained only as amorphous or granular powders and the free acid itself was a non-crystallizable syrup. We believe nevertheless that the substance represents a pure compound because it had been separated previously as a crystalline strychnine salt which appeared perfectly homogeneous.

On cleavage with dilute sulphuric acid in a sealed tube at a temperature of 150° inosite triphosphate decomposes into inosite and phosphoric acid.

EXPERIMENTAL PART.

ISOLATION OF THE SUBSTANCE FROM WHEAT BRAN AS A BARIUM SALT.

The wheat bran was digested over night in 0.2 per ct. hydrochloric acid. It was then strained through cheesecloth and filtered. The free acid in the extract was nearly neutralized by adding a dilute solution of barium hydroxide until a slight permanent precipitate remained. A concentrated solution of barium chloride was added and the precipitate allowed to settle over night. The supernatant liquid was syphoned off and the residue centrifugalized.

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[6] *Jour. Chem. Soc.* 105: 535, 1914.

The precipitate was finally brought upon a Büchner funnel and freed as much as possible from the mother-liquor and then washed in 30 per ct. alcohol. For further purification the substance was precipitated alternately six times from about 1 per ct. hydrochloric acid with barium hydroxide (Kahlbaum, alkali free) and six times with about an equal volume of alcohol.

After this treatment the substance was obtained as a snow-white, amorphous powder. It was free from inorganic phosphate, and bases other than barium could not be detected. But it still contained oxalates from which it was freed in the manner described in a former paper.[7] The substance was finally precipitated from about 1 per ct. hydrochloric acid with alcohol, filtered and washed free of chlorides with dilute alcohol and then in alcohol and ether and dried in vacuum over sulphuric acid. The dry preparation weighed about 66 grams.

This crude acid salt was rubbed up in a mortar with about 500 c.c. of cold water, allowed to stand a few hours and then filtered and washed with water, alcohol and ether and dried in vacuum over sulphuric acid. The water-insoluble residue weighed about 30 grams.

The water-soluble portion contained in the filtrate was precipitated with barium hydroxide and reserved for a future investigation.

PREPARATION OF THE STRYCHNINE SALT.

The water-insoluble portion of the barium salt mentioned above was suspended in water and the barium precipitated with slight excess of dilute sulphuric acid. The barium sulphate was removed and the filtrate precipitated with excess of copper acetate. The copper precipitate was filtered and washed with water until the washings gave no reaction with barium chloride. It was then suspended in water and the copper precipitated with hydrogen sulphide and the copper sulphide filtered off.

The solution containing the free organic phosphoric acid was diluted to about 2 liters with water and heated on the water-bath and 44 grams of powdered strychnine added. After heating for a few minutes the strychnine was dissolved. The solution was filtered and concentrated in vacuum at a temperature of 45° to 50° to about one-half of the volume. The strychnine salt soon began to separate in long needle-shaped crystals. After standing in the ice chest over night the crystals were filtered off and washed in ice-cold water and finally in absolute alcohol and ether and dried in the air. Yield 45.8 grams.

For further purification the substance was twice recrystallized from hot water. It was then obtained in pure white needle-shaped crystals which looked perfectly homogeneous.

From more concentrated solutions the substance sometimes separates in the form of colorless plates which differ from the needle-shaped crystals in that they contain about 4 per ct. more of water of crystallization.

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[7] *Jour. Biol. Chem.* 18:425, 1914; and N. Y. Agrl. Expt. Sta. Tech. Bull. 36, 1914.

The strychnine salt has no sharp or definite melting point. Heated in a capillary tube it softens at about 200° C. but it does not melt completely even at a much higher temperature. On moist litmus paper it shows an acid reaction. The substance does not change in color on drying at 105° C.

For combustion, the substance was mixed with fine copper oxide. After drying at 105° C. in vacuum over phosphorus pentoxide it was analyzed.

The needle-shaped crystals gave the following:

0.1534 gm. subst. gave 0.0901 gm. H_2O and 0.3329 gm. CO_2.
0.2944 gm. subst. gave 0.0702 gm. $Mg_2P_2O_7$.
0.1175 gm. subst. gave 6.75 c.c. nitrogen at 22° C. and 763 mm.
0.1688 gm. subst. lost 0.0154 gm. H_2O on drying.
0.1982 gm. subst. lost 0.0183 gm. H_2O on drying.
Found: $C = 59.18$; $H = 6.57$; $P = 6.64$; $N = 6.56$; $H_2O = 9.12$ and 9.23 per ct.

The plate-shaped crystals gave the following:

0.1786 gm. subst. gave 0.0993 gm. H_2O and 0.3909 gm. CO_2.
0.4972 gm. subst. gave 0.1089 gm. $Mg_2P_2O_7$.
0.1955 gm. subst. lost 0.0256 gm. H_2O on drying.
0.5997 gm. subst. lost 0.0783 gm. H_2O on drying.
Found: $C = 59.60$; $H = 6.22$; $P = 6.10$; $H_2O = 13.09$ and 13.05 per ct.

These compounds apparently do not represent any definite strychnine salt of inosite triphosphate but it would seem as if they were mixtures of the tri- and tetrastrychnine salts.

For tri-strychnine inosite triphosphate, $C_6H_{15}O_{15}P_3(C_{21}H_{22}N_2O_2)_3 = 1422$.
Calculated: $C = 58.23$; $H = 5.70$; $P = 6.54$; $N = 5.90$ per ct.

For tetra-strychnine inosite triphosphate, $C_6H_{15}O_{15}P_3(C_{21}H_{22}N_2O_2)_4 = 1756$.
Calculated: $C = 61.50$; $H = 5.86$; $P = 5.30$; $N = 6.37$ per ct.

PREPARATION OF THE BARIUM SALT FROM THE STRYCHNINE SALT.

The recrystallized strychnine salt, 27 grams, was dissolved in about 750 c.c. of hot water and the solution rendered alkaline with ammonia. After standing in ice water for some time the strychnine was filtered off. The filtrate was shaken with several portions of chloroform to remove the last traces of strychnine.

The solution, which contained the ammonium salt of the organic phosphoric acid, was precipitated by adding a solution of barium chloride in excess. After settling over night, the precipitate was filtered and washed several times with water. It was then dissolved in 1 per ct. hydrochloric acid, filtered, and precipitated with barium hydroxide in excess. The precipitate was filtered and washed with water until free from chlorides. It was again dissolved in 1 per ct. hydrochloric acid, filtered, and the solution rendered neutral to litmus with barium hydroxide. The precipitate was filtered and washed free of chlorides with water and then in alcohol and ether and dried in vacuum over sulphuric acid. The substance was a pure white, amorphous powder. On moist litmus paper it showed a very faint acid reaction. It was free from nitrogen.

For analysis it was dried at 100° in vacuum over phosphorus pentoxide.

0.2323 gm. subst. gave 0.0370 gm. H_2O and 0.0758 gm. CO_2.
0.2085 gm. subst. gave 0.1668 gm. $BaSO_4$ and 0.0868 gm. $Mg_2P_2O_7$.
Found: $C = 8.89$; $H = 1.78$; $P = 11.60$; $Ba = 47.07$ per ct.

The substance was again dissolved in 1 per ct. hydrochloric acid and the solution neutralized to litmus with barium hydroxide. It was filtered, washed free of chlorides with water and then in alcohol and ether and dried in vacuum over sulphuric acid.

It was analyzed after drying as before and the following results obtained:

0.3168 gm. subst. gave 0.0481 gm. H_2O and 0.0972 gm. CO_2.
0.2366 gm. subst. gave 0.1968 gm. $BaSO_4$ and 0.0960 gm. $Mg_2P_2O_7$.
Found: $C = 8.36$; $H = 1.69$; $P = 11.31$; $Ba = 48.94$ per ct.

For the neutral barium salt of inosite triphosphate, $C_6H_9O_{15}P_3Ba_3 = 826$.
Calculated: $C = 8.71$; $H = 1.08$; $P = 11.25$; $Ba = 49.88$ per ct.

In the two analyses reported above the carbon is somewhat low. It must be noted, however, that these barium salts burned with extreme difficulty. Traces of carbon remained after prolonged heating in a current of oxygen. The residues were mixed with fine copper oxide and re-burned when one or two milligrams of carbon dioxide were obtained, but we believe that the combustion even under these conditions was incomplete.

PREPARATION OF THE ACID BARIUM SALT.

The above neutral barium salt was dissolved in the minimum quantity of 1 per ct. hydrochloric acid, the solution was filtered, and precipitated by adding about an equal volume of alcohol. The resulting precipitate was filtered, washed free of chlorides with dilute alcohol and then in absolute alcohol and ether and dried in vacuum over sulphuric acid. The substance was then a pure white, amorphous powder which showed a strong acid reaction on moist litmus paper.

It was analyzed after drying at 105° in vacuum over phosphorus pentoxide.

0.2588 gm. subst. gave 0.0538 gm. H_2O and 0.1046 gm. CO_2.
0.1691 gm. subst. gave 0.1027 gm. $BaSO_4$ and 0.0890 gm. $Mg_2P_2O_7$.
Found: $C = 11.02$; $H = 2.32$; $P = 14.67$; $Ba = 35.74$ per ct.

In the combustion of this substance a practically white ash was obtained.

This compound is evidently a complex acid salt of inosite triphosphate and agrees with the following formula:

$C_{18}H_{35}O_{45}P_9Ba_5 = 1937$.
(Calculated: $C = 11.15$; $H = 1.80$; $P = 14.40$; $Ba = 35.46$ per ct.) which may be graphically represented as follows:

$$\begin{array}{ll} C_6H_{12}O_{15}P_3 = & Ba \\ & > Ba \\ C_6H_{11}O_{15}P_3 = & Ba \\ & > Ba \\ C_6H_{12}O_{15}P_3 = & Ba \end{array}$$

That is, three molecules of mono-barium inosite triphosphate joined by two atoms of barium. Whether it is a compound as represented above or a mixture of various acid salts of inosite triphosphate can hardly be determined.

PREPARATION OF THE FREE ACID.

The barium salt from above was suspended in water and the barium precipitated with a slight excess of dilute sulphuric acid. The barium sulphate was filtered off and the filtrate precipitated with excess of copper acetate. The copper precipitate was filtered and washed with water until it gave no reaction with barium chloride. It was then suspended in water and decomposed with hydrogen sulphide. The copper sulphide was filtered off and the filtrate evaporated in vacuum at a temperature of 40°–45° to small bulk and then dried in vacuum over sulphuric acid. The substance was then obtained as a practically colorless syrup. After continued drying it forms a hard, sticky hygroscopic mass. It is extremely soluble in water and also readily, soluble in alcohol and in absolute alcohol. Much time was consumed in endeavoring to obtain it in crystalline form but without success. The syrupy substance was therefore analyzed after drying first for several days in vacuum over sulphuric acid at room temperature and finally at 100° C. in vacuum over phosphorus pentoxide. On drying at this temperature it turned quite dark in color.

0.1685 gm. subst. gave 0.0557 gm. H_2O and 0.1054 gm. CO_2.
0.1693 gm. subst. gave 0.1363 gm. $Mg_2P_2O_7$.

Found: C = 17.06; H = 3.69; P = 22.44 per ct.
For inosite triphosphoric acid $C_6H_{15}O_{15}P_3 = 420$.
Calculated: C = 17.14; H = 3.57; P = 22.14 per ct.

In the above combustion a slight residue of unburned carbon remained enclosed in the fused metaphosphoric acid. It was mixed with some fine copper oxide and again burned when a few additional milligrams of carbon dioxide was obtained.

PROPERTIES OF INOSITE TRIPHOSPHORIC ACID.

The reactions of this acid differ in several particulars from phytic acid or inosite hexaphosphate.

The concentrated aqueous solution gives no precipitate with ammonium molybdate either in the cold or on warming. The cold aqueous solution of inosite hexaphosphate gives a white crystalline precipitate with ammonium molybdate.

The aqueous solution of the acid is not precipitated with silver nitrate. Inosite hexaphosphate gives a white amorphous precipitate with silver nitrate in excess. However, a solution of inosite triphosphate neutralized with ammonia gives a white amorphous precipitate with silver nitrate.

An aqueous solution of inosite triphosphoric acid when added to a solution of egg albumen causes only a slight turbidity — on longer standing a white precipitate separates slowly. Inosite hexaphosphate precipitates egg albumen immediately.

The acid is very soluble in water and readily soluble in alcohol and absolute alcohol — from the latter solution it is precipitated by ether in small oily drops.

The acid is not precipitated by barium or calcium chlorides but alcohol produces in these solutions white amorphous precipitates; these salts are likewise precipitated with ammonia.

CLEAVAGE OF INOSITE TRIPHOSPHORIC ACID INTO INOSITE AND PHOSPHORIC ACID.

One gram of the acid, dissolved in a little water, was heated with 10 c.c. of $\frac{5N}{1}$ sulphuric acid in a sealed tube for three hours to 150°–155°. The contents of the tube were then slightly yellowish brown in color. The sulphuric and phosphoric acids were precipitated with barium hydroxide and the inosite isolated in the usual way. Unfortunately a portion of the solution was lost but from what remained 0.15 gram inosite was obtained. After twice recrystallizing from dilute alcohol with addition of ether, 0.12 gram of inosite in the characteristic needle-shaped crystals was obtained. It gave the reaction of Scherer and melted at 222° C. (uncorrected). After mixing with some previously isolated and analyzed inosite the melting point did not change. The substance was therefore undoubtedly inosite and the analysis was omitted.

Although the barium salts described in this paper were amorphous and the inosite triphosphoric acid itself was a non-crystallizable syrup we believe that the substances were pure. The basis for this belief rests upon the fact that they had been prepared from the recrystallized strychnine salt which appeared perfectly homogeneous.

We have been unable to complete the investigation of the water-soluble portion of the barium salt mentioned on page 7. We wish, however, to record the following data although it is very incomplete.

After the aqueous solution had been precipitated with barium hydroxide, as already mentioned, the precipitate was filtered and washed in water. It was then dissolved in the minimum quantity of about 2 per ct. hydrochloric acid, filtered and precipitated with about an equal volume of alcohol. The voluminous amorphous precipitate was filtered and washed free of chlorides with dilute alcohol and then in absolute alcohol and ether and dried in vacuum over sulphuric acid. The dry substance weighed 38 grams.

It was again rubbed up in a mortar with about 200 c.c. of cold water, allowed to stand a short while and then filtered, washed in water, alcohol and ether and dried in vacuum over sulphuric acid. The water-insoluble portion weighed 10.3 grams.

The filtrate was concentrated in vacuum at a temperature of 40° C. to about 100 c.c. As the concentration proceeded a small quantity of a heavy white barium salt separated. It was not definitely crystalline and it only weighed 0.9 gram. The aqueous solution, about 100 c.c., contained therefore about 27 grams of the original substance. It was found impossible to obtain anything crystalline from this solution. However, on heating to boiling a heavy semi-crystalline or granular powder separated. This was filtered and washed in hot water, alcohol and ether and dried in the air. It weighed 1.7 grams.

The filtrate from above was precipitated by adding about half a volume of alcohol. The amorphous, white precipitate was filtered, washed and dried in vacuum over sulphuric acid.

A further quantity of substance was obtained by adding more alcohol to the filtrate which was likewise filtered, washed and dried.

These three fractions were analyzed after drying at 105° in vacuum over phosphorus pentoxide.

The semi-crystalline or granular substance gave the following:

$C = 10.14; H = 1.90; P = 13.18; Ba = 39.60; H_2O = 12.11$ per ct.

These results agree very closely with a dibarium salt of inosite triphosphate:

For $C_6H_{11}O_{15}P_3Ba_2$.

Calculated: $C = 10.41; H = 1.59; P = 13.45; Ba = 39.79$ per ct.

The first amorphous precipitate gave:

$C = 12.07; H = 2.30; P = 13.93; Ba = 33.70$ per ct.

The second amorphous precipitate gave:

C = 13.54; H = 2.74; P = 13.32; Ba = 32.38 per ct.

Lack of time has prevented the further examination of these substances but we hope to complete the investigation later.

From the results recorded it is evident that the organic phosphoric acids contained in the preparation used in this investigation consisted principally of inosite triphosphoric acid. The amorphous barium salts analyzed above may have contained some inosite diphosphoric acid or some other organic phosphoric acid. In addition to the above it must be noted that some inosite monophosphate described in an earlier paper had been isolated from this same wheat bran.

The author desires to express his appreciation and thanks to His Excellency Prof. E. Fischer for the interest shown in the work reported in this paper.

II. THE HYDROLYSIS OF PHYTIN BY THE ENZYME PHYTASE CONTAINED IN WHEAT BRAN.*

(Twelfth paper on phytin.)

INTRODUCTION.

It has been shown by the investigations of Suzuki, Yoshimura and Takaishi [1] that rice bran contains an enzyme which rapidly hydrolyzes phytin with formation of inosite and inorganic phosphoric acid. These authors concluded that wheat bran likewise contained a similar enzyme because the inorganic phosphorus increased in wheat bran extracts on standing.

Plimmer [2] examined a large number of extracts prepared from the intestines, liver, pancreas, castor beans, etc., as to their action on organic phosphorus compounds. While some of these showed a slight cleavage action on phytin, none could be compared in activity to an aqueous extract of wheat bran. The hydrolytic action of these extracts was determined by estimating from time to time the amount of inorganic phosphorus split off from phytin solutions of known concentration.

Since the above experiments clearly demonstrated that large quantities of inorganic phosphate were liberated from phytin by wheat bran extracts, it appeared of interest to determine what products, in addition to inosite and inorganic phosphoric acid, were formed under these conditions. For this purpose wheat bran extract was allowed to act upon a dilute solution of phytin at a temperature of 37°. Inorganic phosphoric acid was determined in the solution from time to time.

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*The work reported in this paper was carried out in the Ludwig Mond Biochemical Research Laboratory of the Institute of Physiology, University College, London.

[1] *Bull. Coll. Agric. Tokyo*, 7:503–512. 1907.

[2] *Biochem. Journ.* 7:43, 1913.

It was found that about two-thirds of the total phosphorus was split off during the first 16 days. Afterwards there was no appreciable change even on standing for about two years.

The solution had been prepared and the original determinations made by Dr. Plimmer. At his suggestion the writer undertook to examine the final reaction mixture for such products as had been formed.

These products were separated into two portions by precipitating the original solution with barium hydroxide. The precipitate contained inorganic barium phosphate, and also those barium salts of organic phosphoric acids that were insoluble in the dilute alkaline solution. The filtrate on the other hand was found to contain inosite monophosphoric acid and free inosite.

The inorganic phosphate and other impurities were removed from the crude barium hydroxide precipitate as will be described in the experimental part. The organic phosphoric acids which remained were obtained as amorphous barium salts. It was impossible to isolate any unchanged barium phytate. It is evident then that all of the phytin had been partially hydrolyzed.

The above amorphous substance appeared to consist mainly of barium inosite triphosphate, but probably mixed with some barium inosite diphosphate. Owing to the difficulty of separating these compounds their isolation was not attempted.

Among the soluble substances which had been formed we were able to isolate and identify inosite monophosphoric acid, a substance which we have previously isolated from wheat bran.[3] In addition to this, the solution also contained some free inosite which was isolated by means of its lead compound.

The action of this enzyme phytase upon phytin appears to proceed in several stages. Only a portion of the phytin is completely decomposed into inosite and phosphoric acid, but all of the phytin is partially hydrolyzed with formation of certain lower phosphoric acid esters of inosite, viz., inosite tri–, di– and monophosphoric acid and inorganic phosphoric acid. The formation of these intermediate products is only possible through the destruction or inhibition of the enzyme before the hydrolysis is complete. The reason for this inhibition is not clear but it may be due to the excess of phosphoric acid which is liberated.

It is interesting to note, and we call particular attention to the fact, that the organic phosphoric acids which remain as intermediate products of the action of the enzyme upon phytin, viz., inosite triphosphoric acid and inosite monophosphoric acid, are identical with the substances which we have isolated previously from wheat bran after it has been digested in 0.2 per ct. hydrochloric acid.

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[3] *Journ. Biol. Chem.* 18:441, 1914; and N. Y. Agrl. Exp. Sta. Tech. Bull. 36, 1914.

EXPERIMENTAL PART.

Commercial phytin, 100 grams, was dissolved in 500 c.c. of water and filtered from the insoluble matter which weighed 3.5 grams when dried at 100°. The pale yellow solution was treated with 38 grams of oxalic acid dissolved in about 250 c.c. of water. The calcium oxalate was filtered off, washed and dried. It weighed 48 grams. The solution was diluted to 6000 c.c. with water and was then found to contain 40 grams of phosphorus pentoxide. To it were added 800 c.c. of an aqueous extract of wheat bran which contained 2.2 grams of P_2O_5. The solution was kept under toluol at a temperature of 37°. No hydrolysis occurred in a week. This was evidently due to the strong acid reaction of the solution. It was nearly neutralized with ammonia and 735 c.c. of bran extract containing 1.53 grams of P_2O_5 were added. It was again kept at a temperature of 37° under toluol. In 9 days one-half of the total phosphorus was hydrolyzed; in 16 days two-thirds was hydrolyzed. In 35 days the amount of hydrolysis had not altered and after about two years it was again the same. The total and inorganic phosphorus was determined as described by Plimmer and Page.[4]

The dark-colored solution was filtered and barium hydroxide (Kahlbaum) added in slight excess. After standing over night the precipitate was filtered and washed in water. The filtrate and washings were evaporated on the water bath and the residue was examined as will be described later.

The barium precipitate was dissolved in about 2.5 per ct. hydrochloric acid, filtered, and precipitated by adding about an equal volume of alcohol. The precipitate was filtered and washed in dilute alcohol. The substance was again precipitated four times in the same way. It was then precipitated by barium hydroxide three times from about 2 per ct. hydrochloric acid and finally two times more with alcohol from the same strength hydrochloric acid. After the final filtering it was washed free of chlorides in dilute alcohol and then in alcohol and ether and dried in vacuum over sulphuric acid. The substance was then a snow-white, amorphous powder. It weighed 28.4 grams. It was free from chlorides and inorganic phosphate, and bases other than barium could not be detected.

The substance was then rubbed up in a mortar with 300 c.c. of cold water and allowed to stand with occasional shaking for a few hours. It was then filtered and washed in water, alcohol and ether, and dried in vacuum over sulphuric acid. The dry water-insoluble portion weighed 5.4 grams.

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[4] *Biochem. Journ.* 7:162, 1913.

The filtrate from above was neutralized to litmus with barium hydroxide. The precipitate was filtered and washed in water, alcohol and ether and dried in vacuum over sulphuric acid. It weighed 23.6 grams.

These precipitates were analyzed after drying at 105° in vacuum over phosphorus pentoxide.

The first, water-insoluble portion, gave the following result:

Found : C=11.46 : H=1.93; P=11.59; Ba=39.94 per ct.

This substance is apparently largely composed of the di-barium inosite triphosphate; calculated for this, $C_6H_{11}O_{15}P_3Ba_2$=690.

C=10.43; H=1.59; P=13.47; Ba=39.71 per ct. It is, however, not pure but apparently contains some barium inosite diphosphate because the carbon is high and the phosphorus is low.

The water-soluble substance which was precipitated with barium hydroxide gave the following:

Found: C=9.63; H=1.63; P=10.91; Ba=47.41 per ct.

This substance also appears to consist largely of the neutral barium salt of inosite triphosphate. Calculated for the latter $C_6H_9O_{15}P_3Ba_3$=826. C=8.71; H=1.08; P=11.25; Ba=49.88 per ct. The carbon however is high and the phosphorus as well as barium are low which points to the presence of barium inosite di-phosphate.

In the hope of approximately separating these barium inosite tri- and diphosphates, the substance, 23.6 grams, was digested in dilute acetic acid for several hours with occasional shaking. It was then filtered and washed in water and the insoluble portion dried in vacuum over sulphuric acid. It weighed 10 grams.

The filtrate and washings containing the soluble portion of the substance was precipitated by adding lead acetate in excess. After standing over night the white, amorphous precipitate was filtered and washed in water. It was suspended in water and decomposed by hydrogen sulphide, filtered, and the excess of hydrogen sulphide boiled off. It was again precipitated in the same manner with lead acetate and decomposed with hydrogen sulphide. The solution still contained a considerable quantity of barium. The barium was therefore removed with a slight excess of dilute sulphuric acid. After filtering off the barium sulphate the solution was precipitated by adding copper acetate in excess. The copper precipitate was filtered, washed and suspended in water and decomposed with hydrogen sulphide. After removing the copper sulphide, the filtrate was evaporated in vacuum to small bulk and finally dried in vacuum over sulphuric acid. There remained a thick, nearly colorless syrup. It was readily soluble in alcohol. The addition of chloroform to this solution caused the substance to separate in small oily drops; the addition of ether produced a cloudiness, and on standing a flocculent, amorphous precipitate separated. These solutions could not be brought to crystallize. The acid preparation itself was kept for several weeks in the desiccator over sulphuric acid. It became a hard but sticky mass but showed absolutely no tendency to crystallize. Kept in this manner the color of the preparation gradually darkened.

Since the acid would not crystallize, the syrupy substance was analyzed after drying at 105° in vacuum over phosphorus pentoxide.

Found: C=18.58; H=3.82; P=20.38 per ct.
For inosite triphosphoric acid, $C_6H_{15}O_{15}P_3$=420
Calculated: C=17.14; H=3.57; P=22.14 per ct.
For inosite diphosphoric acid, $C_6H_{14}O_{12}P_2$=340
Calculated: C=21.17; H=4.11; P=18.23 per ct.

This acid preparation is evidently also a mixture of the inosite tri- and diphosphoric acids.

EXAMINATION OF THE FILTRATE AFTER THE WATER-INSOLUBLE BARIUM SALTS HAD BEEN PRECIPITATED.

The filtrate was evaporated, as mentioned on p. 15 and the residue taken up in hot water. It was decolorized with animal charcoal. The solution was neutral in reaction. It strongly reduced Fehling's solution on boiling — possibly due to sugars introduced with the bran extract. The solution was found to contain barium and also phosphorus in organic combination — evidently inosite monophosphate. The aqueous solution was precipitated by adding about an equal volume of alcohol and the white, amorphous precipitate filtered off — the filtrate being reserved for further examination.

Isolation of inosite monophosphate.— The above precipitate, which formed on the addition of alcohol, was dissolved in water, slightly acidified with acetic acid, and then precipitated with lead acetate in excess. After settling, this was filtered, washed in water and suspended in hot water and decomposed with hydrogen sulphide. It was then filtered and the filtrate boiled to expel excess of hydrogen sulphide. It was re-precipitated several times with lead acetate in the same manner until a white lead precipitate was obtained. This was finally decomposed with hydrogen sulphide, filtered, and evaporated to small bulk in vacuum and then dried in vacuum over sulphuric acid until a thick syrup remained. On scratching with a glass rod, this crystallized to a white solid mass. It was digested in alcohol and filtered, washed in alcohol and ether, and dried in the air. It weighed 1.6 grams. It had all the properties of inosite monophosphate. For further purification it was dissolved in a few c.c. of water and filtered. Alcohol was then added until the solution turned cloudy; it was heated until it cleared up and more alcohol was added until a faint permanent cloudiness remained. It was allowed to stand for about 48 hours at room temperature, when the substance had separated in massive, practically colorless crystals. After filtering, washing in alcohol and ether, and drying in the air, 1 gram substance was obtained. When heated in a capillary tube it began to soften at 188°–189° and melted under decomposition and effervescence at 190° C. (uncorrected). The appearance and properties of the substance corresponded exactly with those described for inosite monophosphate and the analysis was therefore omitted.

Isolation of inosite.—The filtrate, after precipitating the above barium salt of inosite monophosphate with alcohol, was evaporated on the water-bath until the alcohol was removed. It still contained barium, chlorides, etc. The barium was quantitatively precipitated with dilute sulphuric acid and the solution again concentrated on the water-bath.

The addition of lead acetate caused no precipitate. Basic lead acetate was then added so long as any precipitate formed. This precipitate was filtered off and discarded. The solution was then heated to boiling and more basic lead acetate added and the solution was finally made strongly alkaline with ammonia and allowed to stand over night. This precipitate was filtered and washed in water and then decomposed in aqueous suspension with hydrogen sulphide. The filtrate was concentrated on the water-bath and the inosite brought to crystallization by the addition of alcohol. After recrystallizing several times 0.5 gram of pure inosite was obtained in the characteristic needle-shaped crystals. It gave the reaction of Scherer and melted at 218° C. (uncorrected).

III. THE HYDROLYSIS OF THE ORGANIC PHOSPHORUS COMPOUND OF WHEAT BRAN BY THE ENZYME PHYTASE.*

(Thirteenth paper on phytin.)

INTRODUCTION.

In several previous papers[1] on the subject of the organic phosphoric acid compounds of wheat bran we have mentioned that when wheat bran is digested in 0.2 per ct. hydrochloric acid, the resulting extract always contains relatively large quantities of inorganic phosphate. Up to the present we have had no data concerning the origin of this inorganic phosphate and it remained to determine whether it was originally present in the bran or if it had been formed during the digestion by hydrolysis from the organic phosphorus compound.

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*The work reported in this paper was carried out in the Ludwig Mond Biochemical Research Laboratory of the Institute of Physiology, University College, London.

[1] *Journ. Biol. Chem.* 12:447, 1912; 18:425, 1914; and N. Y. Agrl. Expt. Sta. Tech. Bull. 22 and 36.

Hart and Andrews,[2] who examined wheat bran as well as a large number of other feeding materials, came to the conclusion that the phosphorus was present almost entirely in organic combination. Some criticism, however, has been offered of their method of estimating inorganic phosphorus and it has been suggested that the time, 15 minutes, which they allowed for digestion was not sufficient for complete extraction.[3]

From the work of Suzuki, Yoshimura and Takaishi[4] and of Plimmer[5] it is evident that wheat bran contains an enzyme which rapidly hydrolyzes a portion of the organic phosphorus into inorganic phosphoric acid. The quantitative determinations of the activity of this enzyme on phytin or inosite hexaphosphate reported in the preceding paper shows that some two-thirds of the total phosphorus of the phytin was eliminated as inorganic phosphoric acid in about 16 days. Since a small quantity of wheat bran extract is capable of hydrolyzing phytin to such an extent, it is evident that the organic phosphoric acid compound originally present in the bran would also be hydrolyzed on digestion under the same conditions.

The determinations herein reported were undertaken in the hope of throwing some light upon this question. It was also hoped to determine the cause of the large percentage of inorganic phosphoric acid in extracts obtained on digesting wheat bran in 0.2 per ct. hydrochloric acid.

The results show that the enzyme phytase contained in the wheat bran very rapidly hydrolyzes the organic phosphorus compound of the bran into inorganic phosphoric acid under certain conditions. We have endeavoured to determine under what conditions the maximum activity of the enzyme manifests itself and also the conditions under which its action is either inhibited or destroyed.

When wheat bran is digested in distilled water the hydrolysis begins at once and proceeds with considerable rapidity, and at the end of 24 hours nearly 90 per ct. of the total water-soluble phosphorus is inorganic. The organic and inorganic phosphates of the bran are only partially soluble in the water, and when the extracts, after digesting the bran for 24 hours in water, are acidified with hydrochloric acid, then only some 60 per ct. of the total dissolved phosphorus compounds are inorganic. (See Table II). This result is not perceptibly altered by digesting the bran in water for 48 hours and then acidifying. (See Table III.)

When the bran is digested in 0.2 per ct. hydrochloric acid the rate of hydrolysis is greater than with pure water. The actual amounts of both organic and inorganic phosphorus are greater in the dilute acid than in the aqueous extracts. After 3 hours about one-third of the total phosphorus is inorganic and after 24 hours about three-quarters of the total soluble phosphorus has been hydrolyzed to inorganic phosphoric acid, as is shown in Table V.

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[2] N. Y. Agrl. Expt. Sta. Bull. 238, 1903.

[3] Ohio Agrl. Expt. Sta. Bull. 215.

[4] *Bull. Coll. Agric. Tokyo*, 1907, 7:503–512, 1907.

[5] *Biochem. Journ.* 7:43, 1913.

With 0.2 per ct. acetic acid the hydrolysis is more rapid and more complete than with 0.2 per ct. hydrochloric acid, 85 per ct. in 24 hours (Table VII) and the most complete hydrolysis was obtained with 0.1 per ct. hydrochloric acid, namely, 92 per ct. (Table VIII.)

That the hydrolysis of the organic phosphorus compound is due to enzyme action and not to the acid employed is strikingly illustrated by the fact that with increasing strengths of the hydrochloric acid the amount of inorganic phosphorus rapidly and steadily diminishes. But when 0.5, 1.0 or 2.0 per ct. hydrochloric acid is used, the inorganic phosphorus is practically constant. (Table V.)

The enzyme is remarkably sensitive to certain concentrations of hydrochloric acid. The hydrolyzing action is stimulated by the presence of 0.1 or 0.2 per ct. hydrochloric acid much above that of pure water, but 0.3 per ct. almost inhibits the enzyme activity. With the 0.1 per ct. acid 92 per ct. and with the 0.2 per ct. acid 76 per ct. of the total phosphorus is inorganic, but with 0.3 per ct. acid only about 20 per ct. of the total phosphorus is inorganic. (See Tables V and VIII.)

Since such a slight difference in strength of the hydrochloric acid caused such a great difference in the amount of the inorganic phosphorus, it appeared of interest to determine whether the acid merely inhibited the hydrolysis or if the enzyme was destroyed by it. Some of the bran was digested in 0.5 per ct. hydrochloric acid for 1½ hours and the acid then nearly neutralized with ammonia and the whole allowed to digest for 24 hours. In this case there was no increase in the inorganic phosphorus, showing that hydrochloric acid of this strength completely destroys the enzyme. (Table X.)

The enzyme is also destroyed by digesting the bran in 0.25 per ct. ammonia, as well as by pouring boiling water or boiling 0.2 per ct. hydrochloric acid over the bran. (Tables X and IX.)

Concerning the amount of inorganic phosphorus in wheat bran, it is evident, judging by the results obtained with 0.5, 1.0 and 2.0 per ct. hydrochloric acid as well as on treating bran with boiling water or boiling 0.2 per ct. hydrochloric acid with 0.25 per ct. ammonia, that ordinary bran contains about 0.1 per ct. of phosphorus as inorganic, which represents about 11 per ct. of the total soluble phosphorus. It seems quite certain that under these conditions of extraction no hydrolysis of the organic phosphorus occurs, and we believe that these figures represent the amount of inorganic phosphorus normally present in wheat bran.

These results are not at variance with the findings of Hart and Andrews.[6] After digesting bran in 1.0 per ct. hydrochloric acid for 40 hours, they found 0.087 per ct. of inorganic phosphorus in the extract. This is practically the same as our results, 0.081 per ct.

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[6] Loc. cit.

inorganic phosphorus, after digesting bran for 5 hours in 1.0 per ct. hydrochloric acid. The same authors found only 0.036 per ct. inorganic phosphorus in wheat bran after digesting in 0.2 per ct. hydrochloric acid for 15 minutes. The lower percentage is no doubt due to incomplete extraction and we believe that the higher figures represent the actual amount present.

EXPERIMENTAL PART.

Total and inorganic phosphorus were determined in extracts prepared from wheat bran. The extracts were prepared by digesting wheat bran in water or dilute acid for varying lengths of time; the particulars and details being given at the beginning of each table. Total phosphorus was determined after decomposing by the Neumann method. Inorganic phosphorus was determined as follows: The extract was diluted with some 50 c.c. of water, 15 grams of ammonium nitrate were added and then warmed to 65° on the water bath. It was then strongly acidified with nitric acid and the phosphorus precipitated with ammonium molybdate and the solution kept at the above temperature for half an hour. Under these conditions there is no danger of cleavage of the organic phosphorus — at least weighable quantities of phosphorus are not precipitated during this time from preparations which are free from inorganic phosphate. Plimmer[7] has also shown that it is necessary to heat phytin solutions with $\frac{N}{1}$ or $\frac{2N}{1}$ nitric acid for several hours to a temperature of 75° or higher before appreciable quantities of inorganic phosphorus are split off.

The phosphomolybdate precipitate was then filtered off and the phosphorus determined as magnesium pyrophosphate in the usual way.

The digestions were made throughout these experiments at room temperature, about 16° C.

Ten grams of the bran were digested in 100 c.c. of water for the time mentioned and then filtered and 20 c.c. used for each determination. The same quantities were used throughout.

Table I.— Changes in Condition of Phosphorus in Wheat Bran by Water Digestion.

Time.	Total phosphorus in extract.	Inorganic phosphorus in extract.	Part of total phosphorus in inorganic form.
	Per ct.	*Per ct.*	*Per ct.*
½ hour	0.362	0.165	45.77
1 "	0.420	0.239	56.95
4 "	0.508	0.383	75.34
20 "	0.655	0.576	88.00
24 "	0.747	0.660	88.43

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[7] *Biochem. Journ.* 7:72, 1913.

It will be noticed that the hydrolysis is greatest during the first four hours. The percentage of phosphorus represents only that amount which was soluble in the water.

After digesting in water for 24 hours and then acidifying with hydrochloric acid and shaking for half an hour the following results were obtained:

TABLE II.— CHANGES IN CONDITION OF PHOSPHORUS IN WHEAT BRAN AFTER WATER DIGESTION AND ACIDIFYING.

Time.	Total phosphorus in extract.	Inorganic phosphorus in extract.	Part of total phosphorus in inorganic form.
	Per ct.	*Per ct.*	*Per ct.*
24 hours	1.06	0.649	60.85

After digesting the bran for 48 hours in water and then adding 100 c.c. of 2 per ct. hydrochloric acid and allowing to stand for another 24 hours, the following results were obtained:

TABLE III.— CHANGES IN CONDITION OF PHOSPHORUS IN WHEAT BRAN AFTER WATER DIGESTION, ACIDIFYING AND STANDING.

Time.	Total phosphorus in extract.	Inorganic phosphorus in extract.	Part of total phosphorus in inorganic form.
Hrs.	*Per ct.*	*Per ct.*	*Per ct.*
48 in water, 24 in weak acid	1.27	0.803	62.79
48 in water, 24 in weak acid	1.28	0.796	62.13

The addition of toluol to the water appears to diminish the amount of phosphorus dissolved without affecting the degree of hydrolysis.

TABLE IV.— EFFECT OF TOLUOL ON HYDROLYSIS OF PHOSPHORUS COMPOUNDS IN WHEAT BRAN.

Time: with toluol.	Total phosphorus in extract.	Inorganic phosphorus in extract.	Part of total phosphorus in inorganic form.
Hrs.	*Per ct.*	*Per ct.*	*Per ct.*
24	0.518	0.462	89.25

Using hydrochloric acid as the extracting medium, the strength varying from 0.2 to 2.0 per ct., the following results were obtained:

10 grams of bran were digested in 100 c.c. of the acid for the length of time mentioned in the table. It was then filtered and 20 c.c. of the filtrate used for each determination.

TABLE V.—EFFECT OF CONCENTRATION OF ACID ON HYDROLYSIS OF PHOSPHORIC ACID COMPOUND IN WHEAT BRAN.

Solvent.	Time.	Total phosphorus in extract.	Inorganic phosphorus in extract.	Part of total phosphorus in inorganic form
HCl, per ct.	*Hrs.*	*Per ct.*	*Per ct.*	*Per ct.*
0.2	3	1.130	0.415	36.52
0.2	24	1.200	0.925	76.87
0.3	24	0.999	0.203	20.22
0.4	24	0.939	0.146	15.61
0.5	20	0.922	0.124	13.44
1.0	5	0.894	0.081	9.13
2.0	30	1.080	0.117	10.83

The presence of toluol did not materially alter these results. Hydrochloric acid, 0.5 per ct. after 20 hours, with toluol gave the following :

TABLE VI.—EFFECT OF TOLUOL ON HYDROLYSIS OF PHOSPHORUS COMPOUNDS IN WHEAT BRAN.

Time: with HCl and toluol.	Total phosphorus in extract.	Inorganic phosphorus in extract.	Part of total phosphorus in inorganic form.
Hrs.	*Per ct.*	*Per ct.*	*Per ct.*
20	0.890	0.117	13.14

When the bran is digested in dilute acetic acid the hydrolysis is greater than with the same strength hydrochloric acid, as shown by the following results:—

TABLE VII.—EFFECT OF ACETIC ACID ON HYDROLYSIS OF PHOSPHORIC ACID COMPOUND IN WHEAT BRAN.

Solvent.	Time.	Total phosphorus in extract.	Inorganic phosphorus in extract.	Part of total phosphorus in inorganic form.
Acetic acid, per ct.	*Hrs.*	*Per ct.*	*Per ct.*	*Per ct.*
0.2	3	1.21	0.695	57.03
0.2	24	1.23	1.050	85.54

The maximum activity of the enzyme, as shown by the greatest hydrolysis, was obtained by digesting bran for 48 hours in water and then adding 0.1 per ct. hydrochloric acid and allowing to stand for another 24 hours. Ten grams of bran were digested in 100 c.c. of water for 48 hours and then 100 c.c. of 0.2 per ct. hydrochloric acid added. After standing for 24 hours more it was filtered and 20 c.c. of the filtrate used for each determination.

TABLE VIII.—MAXIMUM HYDROLYSIS OF PHOSPHORIC ACID COMPOUND IN WHEAT BRAN.

Time.	Total phosphorus in extract.	Inorganic phosphorus in extract.	Part of total phosphorus in inorganic form.
Hrs.	*Per ct.*	*Per ct.*	*Per ct.*
72	1.24	1.14	92.37

DESTRUCTION OF THE ENZYME "PHYTASE" BY HEAT.

As is shown by the following experiments the hydrolytic action of the enzyme is completely destroyed when bran is exposed to the action of boiling water or boiling dilute hydrochloric acid for a short time. Ten grams of bran were placed in an Erlenmeyer flask and 100 c.c. of boiling water poured over it. It was then heated for a few minutes until the water boiled. It was allowed to digest for 24 hours at room temperature. Another lot of bran was treated in the same way but using 0.2 per ct. hydrochloric acid instead of water. The resulting extracts could not be filtered. The whole was therefore diluted with 100 c.c. of 2 per ct. hydrochloric acid and allowed to stand a few minutes to settle. Lots of 20 c.c. of the liquid were then taken for each determination.

TABLE IX.—EFFECT OF BOILING WATER OR BOILING ACID ON HYDROLYSIS OF PHOSPHORIC ACID COMPOUND IN WHEAT BRAN.

Solvent.	Time.	Total phosphorus in extract.	Inorganic phosphorus in extract.	Part of total phosphorus in inorganic form.
	Hrs.	*Per ct.*	*Per ct.*	*Per ct.*
Boiling water	24	0.886	0.108	12.66
Boiling 0.2% HCl	24	1.140	0.105	9.22

The hydrolytic action of the enzyme is likewise destroyed by exposing bran for a short time to 0.5 per ct. hydrochloric acid or by digesting bran in dilute ammonia. Ten grams of bran were digested in 100 c.c. of 0.5 per ct. hydrochloric acid for 1½ hours. The acid was then nearly neutralized with ammonia, leaving the solution faintly acid, and then standing for 24 hours. Ten grams of bran were digested in 100 c.c. of 0.25 per ct. ammonia for 24 hours. It was then acidified with dilute hydrochloric acid.

TABLE X.—EFFECT OF STRONG ACID AND OF AMMONIA ON HYDROLYSIS OF PHOSPHORIC ACID COMPOUND IN WHEAT BRAN.

Solvent.	Time.	Total phosphorus in extract.	Inorganic phosphorus in extract.	Part of total phosphorus in inorganic form.
	Hrs.	*Per ct.*	*Per ct.*	*Per ct.*
0.5% HCl............	24	0.661	0.115	17.46
0.25% NH_3...........	24	0.922	0.087	9.51

The results reported in this and the preceding paper will naturally change the interpretation of our previous investigations concerning the nature of the organic phosphorus compound of wheat bran. We have heretofore been under the impression that the substances which we have isolated from wheat bran, after digesting in 0.2 per ct. hydrochloric acid, represented the compounds originally present in the bran. That this supposition is erroneous is evident, since the action of a bran extract on phytin gives rise to identical compounds.

A consideration of the results reported in Table V likewise shows that there is a wide difference between the action of 0.2 and 1.0 per ct. hydrochloric acid on bran. In the first case the extract contains 0.925 per ct. inorganic phosphorus and in the second only 0.081 per ct.

These facts lead to the conclusion that the products which we have previously isolated from wheat bran represent only such intermediate compounds as have been formed by the action of the enzyme phytase upon the original phytin of the bran.

IV. CONCERNING PHYTIN IN WHEAT BRAN.*

(Fourteenth paper on phytin.)

INTRODUCTION.

It has been shown in earlier reports[1] that the organic phosphorus compounds of wheat bran which have been isolated after digesting the bran in 0.2 per ct. hydrochloric acid differ in composition and properties from phytin or inosite hexaphosphate. It has been found that under these conditions several organic phosphoric acids are obtained. Of these we have isolated and identified two, viz., inosite monophosphoric acid[2] and inosite triphosphoric acid.[3]

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*The work reported in this paper was carried out in the Ludwig Mond Bio-chemical Research Laboratory of the Institute of Physiology, University College, London.

[1] *Journ. Biol. Chem.* 12:447, 1912; also 18:425, 1914; and N. Y. Agrl. Expt. Sta. Tech. Bull. 22 and 36.

Patten and Hart,[4] who first investigated the phosphorus compounds of wheat bran, came to the conclusion that the organic phosphoric acid in bran was identical with phytic acid or the "anhydro-oxymethylene diphosphoric acid" of Posternak. These authors isolated the acid preparation which they analyzed after digesting the bran in 0.2 per ct. hydrochloric acid. We have shown conclusively, however, that when wheat bran is digested in this strength hydrochloric acid, the organic phosphorus compounds finally isolated are entirely different in composition from phytin or inosite hexaphosphate.

By the same method as above, i.e., after digesting in 0.2 per ct. hydrochloric acid, we have isolated inosite hexaphosphate from corn,[5] cottonseed meal [5] and oats.[5] All of these preparations were found to be identical with the inosite hexaphosphate prepared from commercial phytin.[6]

It would appear, then, as if wheat bran is the only one of all the various plants and seeds examined which does not contain inosite hexaphosphate. Instead, certain lower inosite phosphoric acids appear to be present. It seems difficult to explain why wheat bran should contain different inosite phosphoric acids from other plants.

The work of Suzuki, Yoshimura and Takaishi[7] and of Plimmer[8] on the presence of an enzyme in wheat bran which rapidly hydrolyzes phytin with formation of inorganic phosphoric acid, particularly in connection with the two preceding investigations, offered a key to the solution of this problem. The fact that the action of a wheat bran extract on commercial phytin produced products identical with those which we have previously isolated from wheat bran itself, viz., principally inosite triphosphoric acid and inosite monophosphoric acid, led to the thought that the organic phosphorus compound originally present in bran was probably hydrolyzed during the extraction with 0.2 per ct. hydrochloric acid with formation of inorganic phosphoric acid and lower inosite phosphoric acids. This opinion was fully confirmed by the results reported in the preceding paper. It is shown there that inorganic phosphoric acid is liberated rapidly when wheat bran is digested in water, in 0.1 and in 0.2 per ct. hydrochloric acid, as well as in 0.2 per ct. acetic acid. This rapid formation of inorganic phosphoric acid from the organic phosphorus compound would naturally preclude the possibility of isolating the original substance from extracts prepared by digesting the material in the above solutions. The only products possible of isolation would be such intermediate substances as had escaped the hydrolytic action of the enzyme. The previous determinations concerning the activity of the enzyme showed, however, that the use of hydrochloric acid stronger than 0.2 per ct. materially reduced the amount of inorganic phosphate in the extract and that the minimum quantity was present when the bran was extracted with 1 per ct. hydrochloric acid.

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[2] *Journ. Biol. Chem.* 18:441, 1914; and N. Y. Agrl. Expt. Sta. Tech. Bull. 36.
[3] See a preceding article.
[4] *Amer. Chem. Journ.* 31:566, 1904.
[5] *Journ. Biol. Chem.* 17:141, 151, 165, 1914; and N. Y. Agrl. Expt. Sta. Tech. Bull. 32.
[6] Ibid. 17:171, 1914; and N. Y. Agrl. Expt. Sta. Tech. Bull. 32.
[7] *Bull. Coll. Agric. Tokyo.* 7:503–512, 1907.
[8] *Biochem. Journ.* 7:43, 1913.

Wheat bran was therefore extracted for 5 hours with 1 per ct. hydrochloric acid and the organic phosphoric acid in the extract isolated as a barium salt (see Experimental Part). The substance then obtained had entirely different properties and composition from those obtained when wheat bran is digested in 0.2 per ct. hydrochloric acid. After careful purification this salt crystallized in the same form and under the same conditions as the corresponding barium salts of inosite hexaphosphate. So far as crystal form, properties and composition are concerned, there appears to be no difference between the substances isolated from wheat bran and the barium salts of phytic acid or inosite hexaphosphate obtained from other sources. We conclude therefore that all of these materials, viz., wheat bran, corn, oats, cottonseed meal and commercial phytin, contain the same organic phosphoric acid, namely, phytic acid or inosite hexaphosphoric acid, $C_6H_{18}O_{24}P_6$.

This confirms the conclusions of Patten and Hart[9] as to the nature of the organic phosphorus compound of wheat bran. It is somewhat difficult to understand how these authors came to this conclusion since they state that they had extracted the bran with 0.2 per ct. hydrochloric acid, and under these conditions we have found that phytic acid or inosite hexaphosphoric acid is not obtained but principally inosite triphosphoric acid and some inosite monophosphoric acid.

In view of the results reported in this as well as in the two preceding papers, it is evident that the compounds which we have previously isolated from wheat bran, viz., inosite triphosphoric acid and inosite monophosphoric acid, do not represent the organic phosphoric acids originally present in the bran but that they are intermediate products formed from inosite hexaphosphoric acid by the enzyme, "phytase," during the extraction of the bran with the dilute acid.

EXPERIMENTAL PART.

The bran, 700 grams, was digested in 5 litres of 1 per ct. hydrochloric acid for 5 hours. It was then strained through cheesecloth and the liquid filtered. Barium hydroxide (Kahlbaum) was added to the filtrate until the reaction was alkaline. The precipitate was filtered and washed with water and then dissolved in about 3 per ct. hydrochloric acid. The opalescent solution was filtered through charcoal and the filtrate precipitated by adding about an equal volume of alcohol. After standing over night the precipitate was filtered, washed in dilute alcohol and again dissolved in 3 per ct. hydrochloric acid and filtered through charcoal. A dilute solution of barium hydroxide was gradually added to the filtrate until a precipitate began to form. After standing over night the substance had separated out in semicrystalline form. It was filtered and washed in water, dissolved in 3 per ct. hydrochloric acid and precipitated by alcohol. After filtering and washing with dilute alcohol it was again dissolved in the dilute hydrochloric acid and precipitated by barium hydroxide.

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[9] Loc. cit.

The precipitate was still dark colored and it contained some impurities, not completely soluble in the dilute hydrochloric acid, apparently of colloidal nature, which could not be removed by filtration. In order to eliminate these inpurities the barium precipitate was suspended in water and the barium removed with a slight excess of dilute sulphuric acid. The barium sulphate was filtered off and the filtrate precipitated with excess of copper acetate. The copper precipitate was filtered and washed free of sulphates with water. It was then suspended in water and decomposed with hydrogen sulphide. After filtering off the copper sulphide a clear and colorless solution of the free acid was obtained. By these various operations the oxalic acid had also been removed, as, after nearly neutralizing with barium hydroxide and adding barium chloride, no precipitate or turbidity occurred. The solution was precipitated with barium hydroxide, filtered and washed in water. The substance was again twice precipitated with barium hydroxide from 3 per ct. hydrochloric acid and finally twice precipitated with alcohol from the same strength hydrochloric acid. After finally filtering, the substance was washed free of chlorides with dilute alcohol, alcohol and ether, and dried in vacuum over sulphuric acid. It was a snow-white semi-crystalline powder which weighed 11 grams. It was free from chlorides and inorganic phosphate and did not contain any bases except barium.

For analysis it was recrystallized as follows: 2 grams of the substance were dissolved in the minimum quantity of 2 per ct. hydrochloric acid and the free acid nearly neutralized with barium hydroxide and the solution filtered. The clear filtrate was heated to boiling when the substance separated as a heavy crystalline powder. This was filtered and washed in boiling hot water and finally in alcohol and ether and dried in the air. Yield 1.5 grams. It was recrystallized a second time in the same manner except that 20 c.c. of $\frac{N}{1}$ barium chloride were added to the solution before boiling. After filtering, washing and drying, as before, about 1.3 grams substance was obtained. It consisted of fine, microscopic, needle-shaped crystals. It was free from chlorides and the nitric acid solution gave no precipitate with ammonium molybdate, showing that inorganic phosphate was absent.

It was analysed after drying at 105° in vacuum over phosphorus pentoxide.

0.3771 gm. subst. lost 0.0385 gm. H_2O
0.1917 gm. subst. lost 0.0196 gm. H_2O
0.3386 gm. subst. gave 0.0361 gm. H_2O and 0.0794 gm. CO_2
0.2571 gm. subst. gave 0.0269 gm. H_2O and 0.0617 gm. CO_2
0.1715 gm. subst. gave 0.1218 gm. $BaSO_4$ and 0.1026 gm. $Mg_2P_2O_7$
Found: C=6.39; H=1.19; P=16.67; Ba=41.79 per ct.
C=6.54; H=1.17
H_2O 10.20 and 10.22 per ct.

For heptabarium inosite hexaphosphate $(C_6H_{11}O_{24}P_6)_2Ba_7=2267$
Calculated: C=6.35; H=0.97; P=16.40; Ba=42.39 per ct.
For 14 H_2O calculated, 10.00 per ct.

PREPARATION OF THE CRYSTALLINE TRIBARIUM INOSITE HEXAPHOSPHATE.

This was prepared by dissolving 5 grams of the original substance in 2 per ct. hydrochloric acid, nearly neutralizing with dilute barium hydroxide, filtering and adding alcohol gradually until the solution turned cloudy. It was then allowed to stand for two days at room temperature. The substance separated slowly in the form of globular masses or rosettes of microscopic needles. The crystal form was identical with that previously described for the tribarium inosite hexaphosphate. The substance was filtered and washed in dilute alcohol, alcohol and ether, and dried in the air. It was recrystallized a second time by dissolving in the minimum quantity of 2 per ct. hydrochloric acid, filtering, and adding alcohol until a slight permanent cloudiness remained. After standing for two days the substance had separated in the same form as before. It was filtered, washed free of chlorides with dilute alcohol, and then in alcohol and ether and dried in the air. It was obtained as a snow-white crystalline powder. It was free from chlorides and inorganic phosphates.

For analysis it was dried at 105° in vacuum over phosphorus pentoxide.

0.2922 gm. subst. lost 0.0334 gm. H_2O
0.2588 gm. subst. gave 0.0291 gm. H_2O and 0.0648 gm. CO_2
0.1421 gm. subst. gave 0.0944 gm. $BaSO_4$ and 0.0867 gm. $Mg_2P_2O_7$
Found: C=6.82; H=1.25; P=17.00; Ba=39.09 per ct.
H_2O=11.43 per ct.

For tribarium inosite hexaphosphate, $C_6H_{12}O_{24}P_6Ba_3=1066$
Calculated: C=6.75; H=1.12; P=17.44· Ba=38.65 per ct.
For 8 H_2O calculated 11.90 per ct.

Most authors working with organic phosphorus compounds report much difficulty in obtaining proper values for the carbon. This difficulty is particularly great in burning compounds such as those reported above where the percentage of carbon is so low. Under ordinary conditions it is impossible to obtain a complete combustion — the ash is usually more or less dark colored. Some authors recommend mixing the substance intimately with fine copper oxide. This procedure is very serviceable when burning salts of these organic phosphoric acids with organic bases — like the strychnine salts which we have previously reported, but with barium salts we have not found copper oxide to be of much use. In the analyses reported above we have used the following method, for the suggestion of which we are indebted to His Excellency Prof. E. Fischer of Berlin.

The substance is first burned in the usual way in a current of oxygen — the combustion lasting about an hour. The calcium chloride tube and the potash bulb are then weighed. The increase in weight of the calcium chloride tube is taken as the correct weight of the water. The residue in the boat, which is dark colored from particles of unburned carbon, is powdered in an agate mortar with some recently fused potassium bichromate and again placed in the boat, the mortar being rinsed out with some more powdered bichromate. The whole is again burned in the usual way. The potassium bichromate fuses and oxidizes all the carbon in the residue. The increase in weight in the potash bulb is added to the first, giving the total carbon dioxide.

Since the barium salts described above agree in crystal form and composition with salts of inosite hexaphosphoric acid or phytic acid, we believe there can be no doubt that wheat bran contains the same phytin as other plants. We would have recognized this relationship sooner if we had made a series of inorganic phosphorus determinations in wheat bran extracts prepared with water or dilute acids, such as is reported in a preceding paper. We believed, however, that since phytic acid could be isolated from cottonseed meal, oats and corn, after digesting in 0.2 per ct. hydrochloric acid, that the same procedure should also suffice in the case of wheat bran. Moreover, we were following the method of isolation recommended by previous investigators on this subject. The fact that inosite hexaphosphoric acid is obtained from 0.2 per ct. hydrochloric acid extracts of corn, oats, and cottonseed meal, only proves that these materials, with the possible exception of oats, do not contain any enzyme of the nature of the phytase contained in wheat bran. In the case of the phytin preparations isolated from oats[10] we found a considerable amount of water-soluble barium salt of practically the same composition as the barium salts prepared from wheat bran after extracting with 0.2 per ct. hydrochloric acid. We hope to investigate further this matter concerning the distribution of the enzyme phytase in various plants. We also intend to study more closely certain phases of the action of this enzyme, particularly whether it is capable of inducing synthetic reactions. It appears not improbable that an equilibrium exists in the reaction

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[10] *Journ. Biol. Chem.* 17:163, 1914; N. Y. Agrl. Expt. Sta. Tech. Bull. 32, p. 21.

$$C_6H_6O_6\,[PO(OH)_2]_6+6H_2O \rightleftarrows C_6H_6(OH)_6+6H_3PO_4$$

particularly at the stage when one-half of the phosphorus has been split off. The fact that the bulk of the substance ordinarily isolated from wheat bran, after digesting in 0.2 per ct. hydrochloric acid, is inosite triphosphate, supports this view.

The author acknowledges with pleasure his indebtedness to Dr. R. H. A. Plimmer for many suggestions which have been of great assistance in carrying out the work reported in this and the two preceding papers.

FIBRIN.*†

ALFRED W. BOSWORTH.

SUMMARY.

1. Fibrin can combine with both bases and acids to form definite compounds.

2. Fibrin combines with four equivalents of base to form a compound which is neutral to phenolphthalein.

3. Fibrin combines with bases to form a series of three acid salts which contain one, two, and three equivalents of base respectively.

4. All the combinations of fibrin with sodium, potassium, and ammonium are soluble.

5. The calcium fibrinates containing three and four equivalents of calcium are soluble, the calcium fibrinates containing one and two equivalents of calcium being insoluble.

6. Fibrin combined with one equivalent of acid is insoluble, and combined with more than one equivalent of acid is soluble.

7. Pure fibrin, unlike casein, is not strong enough as an acid to decompose calcium carbonate.

8. The molecular weight of fibrin is about 6666.

9. Carbon dioxide precipitates fibrin from a solution of calcium fibrinate, but not from a solution of sodium, potassium, or ammonium fibrinate.

INTRODUCTION.

Certain observations made while working with blood seemed to indicate that fibrin might possess some chemical properties quite similar to those of casein, which have been reported by Van Slyke and Bosworth.[1] Upon investigation it has been found that fibrin resembles casein in many of its reactions towards bases and acids, and it is thought by the author that these reactions may play an important rôle in the phenomenon of the clotting of blood. As a continuation of the work beyond the point reported in this bulletin seems to be out of the scope of this institution, it has seemed best to publish the results obtained in order that they might be available to others interested in the question of the clotting of blood.

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* Published in the *Journal of Biological Chemistry*, 20:91, 1915, as a contribution from the Boston Floating Hospital, Boston, and the Chemical Laboratory of the New York Agricultural Experiment Station, Geneva.

[1] *Jour. Biol. Chem.* 14:203–236, 1913, and Technical Bull. 26 of this Station.

† A reprint of Technical Bulletin No. 41, April, 1915.

EXPERIMENTAL.

METHOD OF PREPARING ASH-FREE FIBRIN.

Fresh ox blood was collected in a large bottle and carried immediately to the laboratory where it was transferred to precipitating jars and allowed to coagulate. The clots were removed, broken into small pieces, and washed in running water to remove the serum and blood corpuscles. The washed masses of fibrin were passed through a meat chopper, placed in an 8-liter bottle, a little toluene was added, and the bottle filled with a 0.2 per ct. solution of sodic hydrate. This solution caused the fibrin to swell, and after about 36 hours the whole contents of the bottle resembled a thin jelly. This jelly was broken up, one-half transferred to another 8-liter bottle, and after the two bottles were filled by the addition of water they were allowed to stand another 36 hours. The jelly was almost completely dissolved, so the contents of the two bottles were filtered, first through cheese cloth, then linen, and finally paper. The clear filtrate was divided into several portions which were placed in 2-liter precipitating jars, diluted with an equal volume of water, and the fibrin was precipitated by the cautious addition of 0.3 per ct. acetic acid. At a certain point a flocculent precipitate appeared which quickly settled to the bottom of the jar.

The supernatant liquid was poured off, the precipitate washed with water, dissolved in dilute sodic hydrate (0.05 per ct.), and again precipitated with acetic acid. This process was repeated three times, the final precipitate being washed with alcohol and ether and dried over sulphuric acid in an evacuated desiccator. The fibrin strongly resembled casein in all stages of its preparation except in its extreme sensitiveness to a slight excess of acid or alkali, for, unlike casein, it is readily soluble in weak acetic acid.

The final product was a very fine, light, white powder which gave the following figures upon analysis.

	Per ct.
Moisture	1.84
Ash in dry substance	0.03
Carbon in dry substance	51.82
Hydrogen in dry substance	6.90
Nitrogen in dry substance	17.21
Sulphur in dry substance	0.95
Oxygen in dry substance*	23.12

In order to show that the preparation obtained was not a substance or mixture of substances resulting from the hydrolysis of fibrin by the alkali used to dissolve the fibrin, the following experiment was performed.

Some of the fibrin, prepared as above, was dissolved in 0.2 per ct. sodic hydrate, allowed to stand for 24 hours at 37° C., and the fibrin precipitated by means of acetic acid. The precipitate, after being washed with water, alcohol, and ether, was found to give the same figures upon analysis as the original preparation. The filtrate contained soluble nitrogen which could not be precipitated by acids, showing that the hydrolysis had occurred, but that the products of the hydrolysis did not contaminate the final preparation of fibrin.

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* By difference.

THE RELATION OF FIBRIN TO BASES.[2]

Combinations with sodium.—One gram of fibrin was found to require 30.7 c.c. of $\frac{N}{50}$ sodium hydroxide to make it neutral to phenolphthalein, or one gram of fibrin combines with 6.14×10^{-4} gram equivalents of sodium to form a compound neutral to phenolphthalein.

One gram of fibrin dissolved in 50 c.c. of $\frac{N}{10}$ sodium hydroxide requires the addition of 42.4 c.c. of $\frac{N}{10}$ HCl to produce the first sign of a precipitate, or one gram of fibrin combines with 1.52×10^{-4} gram equivalents of sodium to form a compound soluble in water.

One gram of fibrin dissolved in 50 c.c. of $\frac{N}{50}$ sodium hydroxide requires the addition of 50 c.c. of $\frac{N}{50}$ HCl to cause the complete precipitation of the fibrin. This proves that fibrin does not form an insoluble salt containing sodium.

Combinations with calcium.—One gram of fibrin was found to require 30.8 c.c. of $\frac{N}{50}$ calcium hydroxide to make it neutral to phenolphthalein, or 1 gram of fibrin combines with 6.16×10^{-4} gram equivalents of calcium to form a compound neutral to phenolphthalein.

One gram of fibrin dissolved in 100 c.c. of $\frac{N}{50}$ calcium hydroxide requires the addition of 77.5 c.c. of $\frac{N}{50}$ HCl to produce the first sign of a precipitate, or one gram of fibrin combines with 4.50×10^{-4} gram equivalents of calcium to form a compound soluble in water.

One gram of fibrin dissolved in 100 c.c. of $\frac{N}{50}$ calcium hydroxide requires the addition of 85.0 c.c. of $\frac{N}{50}$ HCl to cause a complete precipitation of the fibrin, or one gram of fibrin combines with 3.0×10^{-4} gram equivalents of calcium to form a compound insoluble in water. This precipitate is completely dissolved by 5 per ct. solution of sodium chloride.[3]

RELATION OF FIBRIN TO HYDROCHLORIC ACID.

One gram of fibrin dissolved in 50 c.c. of $\frac{N}{50}$ HCl requires the addition of 42.5 c.c. of $\frac{N}{50}$ sodium hydroxide to produce complete precipitation, or one gram of fibrin combines with 1.50×10^{-4} gram equivalents of hydrochloric acid to form a compound insoluble in water.

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[2] For the details of the technique involved in these studies consult the work of Van Slyke and Bosworth upon the caseinates (*loc. cit.*).

[3] Casein forms a similar compound with calcium, *Jour. Biol. Chem.* 14:231, 1913, and Tech. Bull. No. 26, of this Station.

EFFECT OF CARBON DIOXIDE ON SOLUTIONS OF FIBRINATES.

Fibrin is not precipitated by running a stream of carbon dioxide into solutions of sodium, potassium, or ammonium fibrinates while solutions of calcium or barium fibrinates give precipitates of acid fibrinates. Solutions of calcium fibrinate clot upon being exposed to the air, due to the absorption of carbon dioxide.

Fibrin, unlike casein, does not decompose calcium carbonate when these two substances are triturated together in the presence of water.

MOLECULAR WEIGHT OF FIBRIN.

From the sulphur content we have,

$$\text{Mol. Wt.} = N\left[\frac{32.07}{0.95} \times 100\right] = N3375.7. \quad \text{If } N = 2, \text{ then Mol. Wt.} = 6751.4.$$

From the sodium fibrinate containing one equivalent of base we have,

$$\text{Mol. Wt.} = \frac{1}{1.5 \times 10^{-4}} = 6666.6.$$

HUMAN MILK.*†

ALFRED W. BOSWORTH.

INTRODUCTION.

The knowledge of the chemistry of human milk has been derived from a general study of the constituents present and may be summarized by a statement of the amounts of fat, protein, sugar, and salts present. As a result of our somewhat detailed study of cow's milk, methods have been elaborated which allow of a more specific study of the milk constituents and enable us to form more definite opinions as to the condition in which they are present in milk. As these methods have been fully described in a previous paper[1] it will suffice to state here that the milk is first separated by means of a clay filter into two portions: the serum, which contains all the soluble constituents; and the unfilterable portion, which contains those substances which are present in the milk in the form of an emulsion or a colloid. These two portions are then studied separately.

RESULTS OF INVESTIGATIONS.

ACIDITY OF HUMAN MILK.

When the acidity is determined by the method recently published[2] it is found that the acidity of the serum of fresh milk is the same as that of the original whole milk, which proves that the serum contains all the acid bodies in the milk. It will be shown later that this acidity is in all probability due to acid phosphates and that from 3 to 6 c.c. of tenth normal alkali are required to make 100 c.c. of milk neutral to phenolphthalein.

In this connection it is well to call attention to the erroneous idea which has prevailed as to the difference in the acid reaction of human milk and cow's milk. This has been due to the incorrect method used to determine the acidity. The high acid figures previously obtained for cow's milk were due to the interference of the neutral calcium phosphate, $CaHPO_4$, which is present in

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[1] L. L. Van Slyke and A. W. Bosworth: *Journ. Biol. Chem.*, 20:135, 1915; N. Y. Agr. Expt. Sta. Tech. Bul. No. 39, 1915.

[2] Van Slyke and Bosworth: *Journ. Biol. Chem.*, 19:73, 1914; N. Y. Agr. Exp. Sta. Tech. Bul. No. 37, 1914.

† A reprint of Technical Bulletin No. 43, May, 1915.

cow's milk but not in human milk, as will be shown later on in this paper. By using the method mentioned above it is found that 100 c.c. of cow's milk will require the addition of from 4.4 to 7.0 c.c. of tenth normal alkali to make it neutral to phenolphthalein. The acidity of human milk and cow's milk is thus seen to be practically the same, and the practice of adding lime water to modified cow's milk used for infant feeding as a means of correcting the acidity is thus shown to have no foundation.

THE SERUM OF HUMAN MILK.

The serum of fresh human milk resembles water in appearance. It is acid to phenolphthalein and alkaline to methyl orange, which would indicate that the acidity is due to acid phosphates. Its composition, in comparison with that of whole milk, is given in the following table.

TABLE I.—COMPOSITION OF HUMAN MILK AND ITS SERUM.

Constituents.	Original milk.	Milk serum 100 c.c.	Milk constituents in serum.
	Gm.	*Gm.*	*Per ct.*
Fat	3.30	0.00	0.00
Casein	*1.20	0.00	0.00
Albumin		0.131	*(13.10)
Nitrogen in other compounds calculated as protein	0.307	0.307	100.00
Citric acid	0.1055	0.1055	100.00
Phosphorus, organic	0.0008	0.00	0.00
Phosphorus, inorganic	0.0148	0.0148	100.00
Calcium	0.0354	0.0214	60.45
Magnesium	0.0030	0.0030	100.00
Sodium	0.0147	0.0147	100.00
Potassium	0.0711	0.0711	100.00
Chlorine	0.0375	0.0373	100.00

*The determination of casein in the whole milk was very unsatisfactory, and for that reason the amount is not given in the table. It was about 0.2 gm. per 100 c.c. of milk.

THE UNFILTERABLE PORTION OF HUMAN MILK.

By reference to Table I it is seen that that portion of the milk which does not pass through the clay filter contains the fat, the casein, and part of the albumin and calcium. The fat can be removed by extraction with ether, leaving the protein and calcium. It was found impossible to separate the calcium from the protein by any mechanical means; so we conclude that it is in chemical combination with the protein. It is important to note that evidence seems to indicate that the albumin as well as the casein is combined with calcium. This will be investigated more carefully before any definite report is made.

The figures in Table I show that human milk, unlike cow's milk, contains no insoluble inorganic phosphates; *i.e.*, no dicalcium phosphate, $CaHPO_4$. This substance, if it were present, would be found in the portion of the milk which failed to pass through the clay filter.

PRINCIPAL COMPOUNDS OF HUMAN MILK.

As a result of our studies of human milk the following arrangement is offered as representing the probable condition in which the constituents are present in human milk of average composition.

	Per ct.
Fat	3.30
Milk sugar	6.50
Proteins combined with calcium	1.50
Calcium chloride	0.059
Mono-potassium phosphate (KH_2PO_4)	0.069
Sodium citrate ($Na_3C_6H_5O_7$)	0.055
Potassium citrate ($K_3C_6H_5O_7$)	0.103
Mono-magnesium phosphate ($MgH_4P_2O_8$)	0.027

My thanks are due to Dr. Henry I. Bowditch, who has used funds at his disposal to pay for the milk used for this investigation.

THE CASEIN AND SALTS OF GOAT'S MILK.*

ALFRED W. BOSWORTH AND LUCIUS L. VAN SLYKE.

SUMMARY.

1. Casein of goat's milk.— Casein prepared from goat's milk forms a series of compounds with bases in which the combining proportions are the same as in the case of casein prepared from cow's milk. The molecular weight is 8888 and the valency is 8.

2. Soluble and insoluble compounds.— Goat's milk contains two general classes of compounds, those in true solution, and those in suspension or colloidal solution. These two portions can be separated for study by filtering the milk through a porous earthenware filter. The soluble constituents are: Sugar, potassium, sodium and chlorine. Those partly in solution and partly in suspension or colloidal solution are: Albumin, inorganic phosphates, calcium, magnesium and citrates. Constituents entirely in suspension or colloidal solution are: Fat and casein.

3 The insoluble portion of milk separated by the earthenware filter is grayish to greenish white in color, of a glistening appearance and gelatinous consistency. When shaken with water it goes readily into suspension, forming a mixture having the opaque white appearance of milk.

4. Goat's milk contains tri-calcium phosphate as shown by behavior of the insoluble portion toward phenolphthalein and also by the relation between the constituent bases and acids.

5. The real acidity of goat's milk is considerably less than that of cow's milk.

6. Comparison of compounds of goat's milk, cow's milk and human milk.— The amount of salts and the number of different salts in human milk is less than in cow's or goat's milk. The amount of chlorides in goat's milk is larger than in either human or cow's milk. The phosphates in goat's milk are combined with more bases than in the other milks.

I. THE CASEIN OF GOAT'S MILK.

In studying the composition of goat's milk in this laboratory, we found it necessary to know the percentage of phosphorus in the casein prepared from such milk and also the power this casein has of combining with bases to form caseinates. We have prepared casein from goat's milk by the method used in our study of the casein of cow's milk.[1] However, we found it even more difficult to remove all of the calcium phosphate, owing to the fact, shown later (p. 9), that goat's milk contains both tri- and di-calcium phosphate; but by repeating the process of precipitation and redissolving in the presence of neutral potassium oxalate, we finally obtained a preparation in which the percentage of ash was about 0.36.

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* A reprint of Technical Bulletin No. 46, December, 1915.

Below is given the analysis of a preparation of casein made from goat's milk together with the analysis of casein of cow's milk.

PERCENTAGE OF CONSTITUENTS IN MOISTURE-FREE AND ASH-FREE CASEIN.

	From goat's milk	From cow's milk
	Per ct.	*Per ct.*
Ash	0.36	0.06
Carbon	52.50	53.50
Hydrogen	7.16	7.13
Nitrogen	15.67	15.80
Phosphorus	0.71	0.71
Sulphur	0.71	0.72
Oxygen (by difference)	23.25	22.08

RELATION OF CASEIN OF GOAT'S MILK TO BASES.

By applying the details of the methods already published by us,[2] we find that the casein of goat's milk combines with bases to form the same series of salts (caseinates) as in the casein of cow's milk. The results of our work are briefly embodied in the following summary:

(1) One gram of casein combines with 9 x 10^{-4} gram equivalents of base to form a compound (caseinate) neutral to phenolphthalein.

(2) One gram of casein combines with 1.125 x 10^{-4} gram equivalents of ammonium, sodium or potassium to form a soluble caseinate, and there is no other combination of casein with base containing less than 1.125 x 10^{-4} gram equivalents of base for one gram of casein.

(3) One gram of casein combines with 2.25 x 10^{-4} gram equivalents of calcium to form a caseinate which is soluble in water. This caseinate is insoluble in water in the presence of more than a trace of any soluble salt of calcium, barium or strontium.

(4) One gram of casein combines with 1.125 x 10^{-4} gram equivalents of calcium to form a caseinate insoluble in water. This compound is soluble in a warm 5 per ct. solution of sodium chloride, the solvent action being due to an interchange of bases by double

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[1] N. Y. Agr. Exp. Sta. Tech. Bul. No. 26. 1912.

[2] Idem.

decomposition, with the consequent production of soluble sodium caseinate.[8]

VALENCY AND MOLECULAR WEIGHT OF CASEIN OF GOAT'S MILK.

From the preceding data, it can be seen that the valency of casein from goat's milk, like that of casein from cow's milk, is 8.

$\frac{9 \times 10^{-4}}{1.125 \times 10^{-4}} = 8$. The molecular weight would therefore be $\frac{1}{1.125 \times 10^{-4}} = 8888$, and the equivalent weight would be $\frac{8888}{8} = 1111$.

On the basis of the sulphur content we have:

Molecular weight $= N \left(\frac{32.07}{0.71}\right) \times 100 = N\ (4393)$. If N equals 2, the molecular weight equals 8786.

On the basis of the amount of phosphorus contained in casein, we have: Molecular weight $= N \left(\frac{31.04}{0.71}\right) \times 100 = N\ (4372)$. If N equals 2, the molecular weight equals 8744.

II. THE SOLUBLE AND INSOLUBLE COMPOUNDS OF GOAT'S MILK.

When milk is brought into contact with a porous earthenware filter, the serum, consisting of the water and the compounds in true solution, passes through the filter, while the compounds insoluble in water, which are present in suspension (fat and calcium phosphate) or in the form of colloids (casein), remain on the surface of the filter. The details of the method used in separating milk-serum from the other constituents of milk are fully given in Technical Bulletin No. 26 of this Station.

By determining the amounts of the constituents present in the whole milk and in the serum, we are enabled to determine by difference the quantities present in the milk in suspension or colloidal solution.

Table I gives figures obtained by us in working with four samples of goat's milk, in which only the more prominent constituents were determined.

A study of the data contained in Table I enables us to show the general relation of the constituents of milk to the constituents of

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[8] N. Y. Agr. Exp. Sta. Tech. Bul. No. 26. 1912.

TABLE I.—CONSTITUENTS OF GOAT'S MILK.

CONSTITUENTS.	SAMPLE No. 1.			SAMPLE No. 2.			SAMPLE No. 3.			SAMPLE No. 4.		
	In original milk.	In milk-serum.	Percentage of milk constituents in serum.	In original milk.	In milk-serum.	Percentage of milk constituents in serum.	In original milk.	In milk-serum.	Percentage of milk constituents in serum.	In original milk.	In milk-serum.	Percentage of milk constituents in serum.
	Grams per 100 cc.	*Grams per 100 cc.*		*Grams per 100 cc.*	*Grams per 100 cc.*		*Grams per 100 cc.*	*Grams per 100 cc.*		*Grams per 100 cc.*	*Grams per 100 cc.*	
Fat	3.80	0.00	0.00	2.20	0.00	0.00	3.70	0.00	0.00	3.00	0.00	0.00
Sugar	5.22	5.22	100.00	4.82	4.82	100.00	4.52	4.52	100.00	4.45	4.45	100.00
Nitrogen, total	0.520	0.114	21.92	0.492	0.104	21.13	0.450	0.078	17.33	0.404	0.075	18.56
Nitrogen in casein	0.340	0.000	00.00	0.353	0.000	00.00	0.316	0.000	00.00	0.267	0.000	00.00
Nitrogen in albumin	0.090	0.035	38.89	0.059	0.024	40.67	0.060	0.012	20.00	0.067	0.010	14.92
Nitrogen in other proteins	0.090	0.079	87.78	0.080	0.080	100.00	0.074	0.066	89.19	0.070	0.065	92.86
Citric acid	0.1307	0.0991	75.82	0.1485	0.1322	89.02	0.1712	0.1283	74.89	0.1531	0.1379	90.07
Phosphorus, total	0.1206	0.0502	41.63	0.0906	0.0390	43.05	0.0862	0.0392	54.48	0.0841	0.0413	49.11
Phosphorus, organic	0.0153	0.0000	00.00	0.0159	0.0000	00.00	0.0142	0.0000	00.00	0.0120	0.0000	00.00
Phosphorus, inorganic	0.1053	0.0502	47.67	0.0747	0.0390	52.21	0.0720	0.0392	54.44	0.0721	0.0413	57.28
Calcium	0.1632	0.0414	25.37	0.1500	0.0534	35.60	0.1240	0.0351	28.31	0.1144	0.0374	32.69
Magnesium	0.0204	0.0128	62.75	0.0212	0.0132	62.26	0.0206	0.0128	62.19	0.0236	0.0144	61.02
Potassium	0.1700	0.1724	100.00	0.1656	0.1784	100.00	0.2284	0.2284	100.00	0.2084	0.2084	100.00
Sodium	0.0380	0.0380	100.00	0.0400	0.0396	100.00	0.0352	0.0352	100.00	0.0372	0.0376	100.00
Chlorine	0.1578	0.1581	100.00	0.1811	0.1839	100.00	0.2171	0.2168	100.00	0.2597	0.2665	100.00

milk-serum. The following form of statement furnishes a clear summary of the facts:

1. Milk constituents in true solution in milk serum:	2. Milk constituents partly in solution and partly in suspension or colloidal solution:	3. Milk constituents entirely in suspension or colloidal solution:
(a) Sugar.	(a) Albumin.	(a) Fat.
(b) Potassium.	(b) Inorganic phosphates.	(b) Casein.
(c) Sodium.	(c) Calcium.	
(d) Chlorine.	(d) Magnesium.	
	(e) Citrates.	

PROPERTIES AND COMPOSITION OF PORTION OF MILK IN SUSPENSION OR COLLOIDAL SOLUTION.

Some of the constituents of milk are suspended in the form of solid particles in such an extremely fine state of division that they pass through the pores of filter-paper and they do not settle as a sediment on standing, but remain permanently afloat. They can not be seen except by ultra-microscopic methods. When substances are in such a condition, they are said to form a colloidal solution. In passing milk through the Pasteur-Chamberland filtering-tube, the constituents in suspension as solid particles, and in colloidal solution, are retained in a solid mass on the outside of the tube and can therefore be readily obtained for study.

(1) *Appearance.*— When prepared by the method of filtration previously described, the insoluble portion of fat-free milk collecting on the outside of the filtering-tube is grayish to greenish white in color, of a glistening appearance and gelatinous consistency. When dried without purification by treatment with alcohol, etc., it resembles in appearance dried white of egg.

(2) *Behavior with water.*— This deposit of insoluble milk-constituents on the outside of the filtering-tube, when removed and shaken vigorously in a flask with distilled water, goes into suspension and the mixture has the opaque, white appearance of the original milk. The deposit is, of course, more or less mixed with adhering soluble constituents but can be readily purified by shaking with distilled water and filtering several times. The purified material goes readily into suspension on shaking with water and, if treated with a preservative, will remain indefinitely without change other than the separation of fat-globules. It has been held by some that the citrates of milk perform the function of holding the insoluble phosphates in suspension, but this is not supported by the behavior of the insoluble portion shown in our experiments.

(3) *Reaction.*— A suspension of the insoluble constituents of milk, prepared in the manner described above, is alkaline to phenolphthalein. We purified the deposit obtained from 1000 c.c. of milk and

made a suspension of it in water; it was found to be neutral to phenolphthalein before the addition of 10 c.c. of neutral solution of potassium oxalate, but after the addition of neutral potassium oxalate it developed a strongly alkaline reaction to phenolphthalein. We interpret this behavior to mean that the insoluble portion of goat's milk contains an alkaline phosphate, which, being insoluble, does not affect the indicator; but the addition of a solution of neutral potassium oxalate decomposes the insoluble phosphate, resulting in the production of soluble tri-potassium phosphate, which reacts alkaline to phenolphthalein, as will be shown more clearly later (p. 10).

(4) *Composition.*— As shown in Table I, the insoluble portion of goat's milk contains fat, protein, inorganic phosphates, calcium and magnesium. The fat may be separated from the other constituents by extraction with ether or by removal from the original milk through centrifugal force before the milk is filtered through the porous porcelain tubes. We have previously shown that albumin may be adsorbed to some extent by casein[4] and thus partly retained on the filter. In view of these conditions, our studies have been limited to the acids (casein and phosphates) and the bases (calcium and magnesium) present in this portion of the milk.

(5) *Relation between bases and acids in the insoluble portion of goat's milk.*— In order to bring out clearly the relation existing between the bases and the acids in the insoluble portion of the milk, we have prepared tables II and III. Table II is obtained from the figures in Table I, and Table III is obtained by converting the percentage figures of Table II into gram equivalents per 100 c.c. of milk. In making these calculations, we have considered the casein of goat's milk to be octavalent, one gram combining with 9×10^{-4} gram equivalents of base to form a compound neutral to phenolphthalein (page 4). The figures for inorganic phosphorus are obtained by subtracting the amount of phosphorus in the casein (0.71 per ct.) from the total phosphorus.

TABLE II.— AMOUNTS OF CASEIN, INORGANIC PHOSPHORUS, CITRIC ACID, CALCIUM AND MAGNESIUM IN THE INSOLUBLE PORTION OF GOAT'S MILK.

NUMBER OF SAMPLE.	Casein.	Inorganic phosphorus.	Citric acid.	Calcium.	Magnesium.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1	2.17	0.0551	0.0316	0.1218	0.0076
2	2.25	0.0357	0.0163	0.0966	0.0080
3	2.01	0.0328	0.0429	0.0889	0.0078
4	1.70	0.0308	0.0152	0.0770	0.0092

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[4] N. Y. Agr. Exp. Sta. Tech. Bul. No. 39, p. 7. 1914.

TABLE III.— AMOUNTS OF ACIDS AND BASES IN TABLE II EXPRESSED AS GRAM EQUIVALENTS PER 100 C.C. OF MILK.

NUMBER OF SAMPLE.	Casein as octavalent acid.	Phosphorus as di-basic acid	Citric acid as tri-basic acid.	Sum of values of acids.
1	19.5×10^{-4}	35.5×10^{-4}	4.9×10^{-4}	59.9×10^{-4}
2	20.3×10^{-4}	23.0×10^{-4}	2.5×10^{-4}	45.8×10^{-4}
3	18.1×10^{-4}	21.2×10^{-4}	6.7×10^{-4}	46.0×10^{-4}
4	15.3×10^{-4}	19.9×10^{-4}	2.4×10^{-4}	37.6×10^{-4}

NUMBER OF SAMPLE.	Calcium.	Magnesium.	Sum of values of bases.	Excess of base.
1	60.9×10^{-4}	6.3×10^{-4}	67.2×10^{-4}	7.3×10^{-4}
2	48.3×10^{-4}	6.7×10^{-4}	55.0×10^{-4}	9.2×10^{-4}
3	44.5×10^{-4}	6.5×10^{-4}	51.0×10^{-4}	5.0×10^{-4}
4	37.2×10^{-4}	7.7×10^{-4}	44.9×10^{-4}	7.3×10^{-4}

The last column of Table III shows that the amounts of bases in the insoluble portion of goat's milk are in excess of the amounts required to form with the acids that are present salts neutral to phenolphthalein. There is reason to believe that this excess of base is present in combination with the phosphorus in the form of tricalcium phosphate. The evidence supporting this belief is furnished by an examination of the insoluble portion of goat's milk obtained by separation through centrifugal force in a cream-separator.[5]

The bowl of a cream-separator was filled with fat-free milk (about 1000 c.c.) and was whirled for two hours at a speed of 5000 revolutions a minute. The liquid portion of the milk was then taken from the bowl and the deposit (" separator slime "), which had collected on the walls of the bowl, was removed, treated with alcohol and ether, and dried in the manner described in Technical Bulletin 39 of this Station. The same liquid portion of the milk was again placed in the separator-bowl and whirled for an additional two hours, when the deposit was again removed and treated as before. After the removal of the second deposit, the liquid portion of the milk remaining in the separator was nearly as clear as whey, since most of the suspended phosphates and casein had been deposited on the walls of the bowl during the whirling.

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[5] N. Y. Agr. Exp. Sta. Tech. Bul. No. 39. 1914.

The results of the analysis of the dried deposit obtained after each two-hour period of whirling are given in Table IV.

TABLE IV.—COMPOSITION OF INSOLUBLE PORTION ("SEPARATOR SLIME") OF GOAT'S MILK.

DEPOSIT FORMED BY WHIRLING TWO 2-HOUR PERIODS.	Casein.	Total phosphorus.	Phosphorus in casein.	Phosphorus as phosphate.	Calcium.	Ratios of organic to insoluble inorganic phosphorus.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	Org. P.: In. P.
1st 2 hours..........	75.56	2.57	0.54	2.03	4.46	1 : 3.72
2nd 2 hours..........	73.17	2.59	0.53	2.06	4.40	1 : 3.81

Expressing the data in Table IV in the form of gram equivalents per 100 c.c. of milk, we obtain the figures contained in Table V.

TABLE V.—AMOUNTS OF ACIDS AND BASES IN TABLE IV EXPRESSED AS GRAM EQUIVALENTS PER 100 C.C. OF MILK.

	Casein as gram equivalents of acid.	Phosphates as gram equivalents of di-basic acid.	Sum of gram equivalents of casein and phosphates.	Gram equivalents of calcium.	Excess of calcium as gram equivalents.
In 1st deposit.	68.0×10^{-3}	132.2×10^{-3}	200.0×10^{-3}	226×10^{-4}	26.0×10^{-3}
In 2nd deposit.	65.9×10^{-3}	132.8×10^{-3}	198.7×10^{-3}	220×10^{-3}	21.3×10^{-3}

These figures show an amount of calcium in excess of that required to form salts neutral to phenolphthalein with the acids present, casein and phosphoric acid. It should be stated here that these deposits of "separator slime" contain no citric acid. When the deposit is suspended in water in the presence of phenolphthalein, no color appears; but, if a cubic centimeter of a neutral solution of potassium oxalate is added, a pink color appears, becoming more intense after standing one or two minutes. The most obvious explanation of this behavior is that the addition of potassium oxalate results in a reaction between it and the tri-calcium phosphate, tri-potassium phosphate being formed and turning the indicator pink.

THE ACIDITY OF GOAT'S MILK AND ITS SERUM.

When the determination of the acidity of goat's milk and its serum is made by adding neutral potassium oxalate and filtering previous to titration according to the method recently published by us,[6] results are obtained as given in Table VI.

TABLE VI.— THE ACIDITY OF GOAT'S MILK AND ITS SERUM.

NUMBER OF SAMPLE.	NUMBER OF C.C. OF $\frac{N}{10}$ ALKALI REQUIRED TO NEUTRALIZE 100 C.C. OF	
	Milk.	Serum.
1	1.4	6.6
2	3.0	5.6
3	0.6	4.8
4	0.3	5.8
5	0.0	5.0
6	0.0	3.0

There is observable a marked difference between the acidity of the whole milk and that of its serum. This condition is accounted for by the following explanation. In normal goat's milk, which is nearly neutral, there is present in suspension di-calcium phosphate; this phosphate in the presence of the water in the milk undergoes more or less decomposition, for according to the work of Cameron and Hurst[7] water in contact with a solid phase containing calcium phosphate dissolves more acid than base from the solid phase. The result of this action is that the insoluble portion of the milk becomes more basic than the whole milk, as shown above, while the soluble portion becomes more acid. When the solid and liquid portions of milk are separated by treatment on a porous porcelain filter, the soluble acid passes into the serum, the basic compound remaining in the insoluble portion.

In determining the acidity of milk, it should be remembered that the presence of di-calcium phosphate furnishes conditions favorable to the formation of acid phosphate and tri-calcium phosphate, as shown in Technical Bulletin No. 37 of this Station, pp. 4–5, resulting in an increased requirement of alkali for neutralization and apparently a higher acidity if the milk is titrated directly. For this reason the lower acidity obtained after the removal of calcium by neutral potassium oxalate is believed to represent the real acidity of the milk. This point is well illustrated by the following figures:

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[6] N. Y. Agr. Exp. Sta. Tech. Bul. No. 37. 1914.

[7] *Jour. Amer. Chem. Soc.*, 26:905. 1904.

SAMPLE.	NUMBER OF C.C. OF $\frac{N}{10}$ ALKALI REQUIRED TO NEUTRALIZE 100 C.C. OF MILK.	
	Before addition of neutral potassium oxalate.	After addition of neutral potassium oxalate.
Number 1	17.6	1.5
Number 2	21.0	3.0
Number 3	20.6	3.2
Number 4	25.6	8.0
Number 5	20.6	1.4

COMPOUNDS IN GOAT'S MILK.

Based on the results of our study of the composition of goat's milk, the following arrangement is tentatively suggested as representing the forms in which the constituents may be present:

		Per ct.
Fat		3.80
Milk-sugar		4.50
Proteins, combined with calcium		3.10
Salts:		
Di-calcium phosphate	0.092 per ct.	0.94
Tri-calcium phosphate	0.062 per ct.	
Di-magnesium phosphate	0.068 per ct.	
Tri-magnesium phosphate	0.024 per ct.	
Mono-potassium phosphate	0.073 per ct.	
Potassium citrate	0.250 per ct.	
Potassium chloride	0.160 per ct.	
Calcium chloride	0.115 per ct.	
Sodium chloride	0.095 per ct.	
Total solids		12.34

III. COMPARISON OF COMPOSITION OF COW'S MILK, GOAT'S MILK AND HUMAN MILK.

In Technical Bulletins No. 39 and No. 43 of this Station, there are given statements attempting to indicate the individual forms or compounds in which the salts exist in cow's milk and in human milk. The same has been done for goat's milk in Part II of this bulletin.

It is a matter of interest to bring these results together in order to see in what respects these three kinds of milk differ. It is understood, of course, that the arrangement of the constituents is based upon a limited amount of work; we know that there is variation in the quantitative relations of the different compounds. There remains much work to be done in applying our methods to the study of milks produced under a variety of known conditions. These present results are, therefore, presented as tentative in character and are likely to be modified by more extensive work.

TABLE VI.— COMPOUNDS IN COW'S MILK, GOAT'S MILK AND HUMAN MILK.

COMPOUNDS.	Cow's milk.	Goat's milk.	Human milk.
	Per ct.	*Per ct.*	*Per ct.*
Fat	3.90	3.80	3.30
Milk-Sugar	4.90	4.50	6.50
Proteins combined with calcium	3.20	3.10	1.50
Salts:	0.901	0.939	0.313
Di-calcium phosphate	0.175	0.092	0.000
Tri-calcium phosphate	0.000	0.062	0.000
Mono-magnesium phosphate	0.103	0.000	0.027
Di-magnesium phosphate	0.000	0.068	0.000
Tri-magnesium phosphate	0.000	0.024	0.000
Mono-potassium phosphate	0.000	0.073	0.069
Di-potassium phosphate	0.230	0.000	0.000
Potassium citrate	0.052	0.250	0.103
Sodium citrate	0.222	0.000	0.055
Potassium chloride	0.000	0.160	0.000
Sodium chloride	0.000	0.095	0.000
Calcium chloride	0.119	0.115	0.059

In the preceding table, the figures which have special interest are those relating to the salts and we notice the following points in relation to these compounds:

(1) Phosphates. (a) *Cow's milk.*—The insoluble phosphate is di-calcium phosphate; tri-calcium and tri-magnesium phosphates are not present. The soluble phosphates are mono-magnesium and di-potassium and they constitute about two-thirds of the total phosphates. (b) *Goat's milk.*—This differs from cow's milk (1) in containing tri-calcium, di-magnesium, tri-magnesium and mono-potassium phosphates, which are absent from cow's milk, and (2) in containing no mono-magnesium or di-potassium phosphates, which are present in cow's milk. (c) *Human milk* differs very noticeably from both cow's milk and goat's milk in containing no insoluble phosphates but only the soluble compounds, mono-magnesium and mono-potassium phosphates. The phosphates in human milk are much less in amount than in cow's or goat's milk.

(2) Citrates.— All three milks contain potassium citrate, while cow's milk and human milk contain sodium citrate also, but goat's milk does not.

(3) Chlorides are present in goat's milk in much larger amounts than in cow's milk or human milk; the amount in cow's milk is considerably larger than in human milk. In cow's milk and human milk the chloride appears to be calcium chloride, while in goat's milk potassium and sodium chlorides are also present.

(4) The total amount of salts in human milk is about one-third that in cow's or goat's milk. The number of different salts appears to be greatest in goat's milk and least in human milk.

ANALYSES OF GOAT'S MILK.

As a contribution to our knowledge of the general composition of goat's milk and as a matter of convenience for future reference, we append the results of analysis made by us in case of 23 samples obtained from 11 different goats.

NUMBER OF GOAT.	Date of milking.	Specific gravity.	Fat.	Total solids.	Proteins.	Casein.	Ash.
			Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
5	Aug. 2	1.0269	3.7	11.43	2.87	2.10	0.51
5	Aug. 4	1.0269	4.0	11.93	2.86	2.08	0.44
5	Aug. 9	1.0264	3.7	11.47	2.88	2.13	0.49
6	Aug. 2	1.0280	2.5	10.18	2.55	1.90	0.52
6	Aug. 4	1.0278	2.5	9.91	2.24	1.56	0.44
6	Aug. 9	1.0286	2.7	10.49	2.48	1.64	0.48
7	Aug. 2	1.0278	3.8	11.42	2.58	1.95	0.56
7	Aug. 4	1.0286	3.8	11.54	2.58	1.83	0.51
7	Aug. 9	1.0280	3.9	11.80	2.57	1.71	0.57
8	Aug. 2	1.0287	3.0	10.56	2.54	1.78	0.57
8	Aug. 4	1.0282	2.6	10.23	2.37	1.56	0.50
8	Aug. 9	1.0286	3.0	10.73	2.48	1.66	0.49
9	Aug. 2	1.0294	3.4	11.53	3.03	2.12	0.57
9	Aug. 4	1.0295	3.1	11.08	2.78	2.00	0.54
9	Aug. 9	1.0298	3.4	11.11	2.77	1.83	0.51
11	Aug. 2	1.0274	2.4	9.61	2.50	1.86	0.45
11	Aug. 4	1.0266	2.2	9.22	2.27	1.56	0.51
11	Aug. 9	1.0275	2.4	9.66	2.34	1.59	0.43
12	Aug. 2	1.0354	3.6	13.73	4.74	3.78	0.65
12	Aug. 4	1.0359	3.8	14.51	5.21	3.82	0.56
12	Aug. 9	1.0322	5.6	15.18	4.15	3.26	0.53
15	Aug. 2	1.0294	2.2	10.29	3.08	2.32	0.50
15	Aug. 4	1.0300	1.8	9.90	2.98	2.26	0.52
15	Aug. 9	1.0287	3.0	10.23	2.88	2.13	0.53
16	Aug. 2	1.0293	2.8	11.18	3.26	2.64	0.55
16	Aug. 4	1.0294	2.8	10.95	3.30	2.54	0.40
16	Aug. 9	1.0303	3.4	11.79	3.33	2.48	0.61
20	Aug. 2	1.0314	7.8	17.63	4.96	4.06	0.76
20	Aug. 4	1.0336	6.0	16.17	4.95	4.02	0.73
20	Aug. 9	1.0303	8.4	18.55	4.83	3.85	0.80
23	Aug. 2	1.0300	6.3	15.47	3.83	3.14	0.70
23	Aug. 4	1.0296	6.0	15.23	3.70	2.90	0.59
23	Aug. 9	1.0310	6.5	16.13	3.94	3.07	0.68
General average	......	1.0294	3.82	12.12	3.21	2.40	0.55

The data indicate a wide variation in composition. Animals Nos. 20 and 23 were well along in lactation.

REPORT

OF THE

Department of Entomology.

P. J. PARROTT, *Entomologist.*
HUGH GLASGOW, *Associate Entomologist.*
H. E. HODGKISS, *Assistant Entomologist.*
[1] B. B. FULTON, *Assistant Entomologist.*
[2] F. H. LATHROP, *Assistant Entomologist.*
F. Z. HARTZELL, *Associate Entomologist.*
(Connected with Grape Culture Investigations.)

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IV. The grape root-worm.
V. The sinuate pear borer and the leopard moth.

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[1] Absent on leave after June 1.
[2] Appointed June 15.

REPORT OF THE DEPARTMENT OF ENTOMOLOGY.

THE STATUS OF SPRAYING PRACTICES FOR THE CONTROL OF PLANT LICE IN APPLE ORCHARDS.*†

P. J. PARROTT AND H. E. HODGKISS

SUMMARY.

The foliage and fruit of apple trees in New York are subject to attack by three species of plant lice, which are the rosy apple-aphis (*Aphis sorbi* Kalt.), the green apple-aphis (*Aphis pomi* De Geer), and the oat aphis (*Aphis avenae* Fab.). All are injurious to apples, but the two former normally cause the greatest losses in crop production.

The species show differences in habits and structures, while from the standpoint of orchard economy they display marked similarities in their injurious activities. Eggs are laid principally during October and November on succulent twigs, in crevices in the bark or at the bases of the buds. As buds begin to expand during the latter part of April the eggs hatch, and the young aphides seek the green ends of the opening buds. During 1913 and 1914 observations showed that the newly-hatched lice of the different species appeared simultaneously during the period of the swelling and breaking of the buds and until the buds were nearly open at the tips. As opportunity is afforded the insects work into the interior of the buds and seek the protection given by the hairy growth of the unfolding leaves and rudimentary blossom structures. The stem-mothers mature about the time of blossoming and during favorable seasons the production of lice thereafter may be very rapid. The first brood causes injuries to unfolding leaves and immature blossom parts proportionate to their numbers, but the greatest injury to the crop usually occurs during the period coincidental with the life events of blossoming, setting of fruit and the growth of the young apples until they are the size of walnuts. After producing several generations on apples, the rosy aphis and oat

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* Also presented in essentials before the New York State Fruit Growers' Association, Rochester, New York, January 6, 1915.

† A reprint of Bulletin No. 402, April, 1915.

aphis develop winged forms, which seek other plants as summer hosts. The green aphis lives on apple trees all the year, breeding continually during the summer, preferring water sprouts. In occasional years it develops to injurious numbers during late summer.

Injuries from plant lice result chiefly from the extraction of plant juices by the insects which feed upon the foliage and fruits. The work of the aphides during May and June is especially destructive since it occurs during the period when fruit buds are forming and when the vigor of the trees is also required for the development of the young apples of the current season's crop. If favorable conditions exist for rapid increase of pests the leaves become curled and the development of young fruit is checked. During prolonged outbreaks the injured leaves turn brown and drop, causing more or less extensive defoliation. The fruits fail to increase in size and cling tightly to the twigs, forming " cluster " apples.

Efforts to protect bearing apple orchards from plant lice are, as a rule, failures. Experiments by this Station in recent years indicate that the most effective and satisfactory means of protecting the young fruit during its formative stage is the destruction of the plant lice on the expanding buds. The most efficient spraying mixtures are nicotine solution, oil emulsions or soap preparations. The physical features of the location of the orchard, such as the direction and elevation of the slopes of the land, proximity of water and character of soil, have a marked influence on the development of the buds. The time for effective spraying will therefore vary with individual orchards as well as with different varieties of apples.

INTRODUCTION.

The intensive culture of the apple has brought about conditions that have proven exceedingly favorable to injurious insects, certain of which have acquired great vigor and assumed a very dangerous character. In this category are the leaf- and fruit-infesting aphides which, on the basis of their destructive activities during the past ten years, can no longer be overlooked when considered in the light of the permanent prosperity, extension and normal development of apple growing in New York. These pests were the subjects of discussion in Circular 23 of this Station, and some considerations in this account cover somewhat the same ground. The problems are of perennial interest, and before the mass of growers will learn to make much headway with new practices, matters of this character and importance must necessarily be discussed and reconsidered in the light of each season's experience. The proper spraying of orchards, with its varied details, is moreover always a live subject for discussion, regarding which the grower should desire annually to renew his store of knowledge, because of the constant gains in information of life histories and habits of economic species and progress in improved methods of control.

The subject is, for the sake of clearness, considered under the following headings:

1. Species of plant lice injurious to apple foliage and fruit.
2. Mode of attack and results.
3. Stages susceptible to insecticides.
4. Station's experiments and conclusions on methods of control.
5. Comparison of Station's conclusions with spraying practices in other apple-growing sections.
6. Spraying mixtures and recommendations.

In planning this outline the chief purpose is to emphasize certain knowledge and principles which are at the basis of any rational, and it is to be hoped, successful effort to control these pests. The discussion will prove helpful if the information given is brought to bear in spraying operations according to the peculiarities of the circumstances and location of each orchardist.

SPECIES INJURIOUS TO APPLE FOLIAGE AND FRUIT.

The species of plant lice that attack apple foliage and fruits in New York are the rosy apple-aphis (*Aphis sorbi* Kalt.), the green apple-aphis (*Aphis pomi* De Geer), and the oat aphis (*Aphis avenæ* Fab.). All three species are injurious, but the two former cause the greatest damage to apple trees. These insects are briefly characterized as follows:

Rosy aphis.— This is a very common and widespread species in the leading apple-growing sections of the United States. Its eggs are deposited in the autumn in depressions or creases of the bark, especially about the buds, and according to Sanderson[1] the insect may place more of its eggs upon the trunk and less numbers on the twigs than other species. In early spring the young, pale-colored nymphs hatch from the eggs and assemble preferably on the foliage surrounding a fruit cluster, deforming and injuring both leaves and fruit. The species varies greatly in color, from greenish-blue pulverulent females hatching from the eggs to more or less pinkish forms in subsequent broods. The stem-mothers mature about the middle of May or about the time of blossoming of the trees. During favorable conditions the development of the insects from this period may be very rapid, and about three generations of this species occur before the middle of June. Usually by the first week in July in New York the lice leave the apple trees for their summer hosts, among which, according to Mr. W. A. Ross, of Canada, are certain species of plantains.[2] The insects do not appear again until autumn when winged females seek the trees for the purpose of producing sexed individuals.

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[1] Sanderson, E. D., Del. Expt. Sta. Rpt. 13: 156, 1902.

Green apple-aphis.— As with the preceding species the eggs are laid principally during October and November in furrows or crevices of the bark of succulent twigs or at the bases of the buds. As the buds begin to expand during the latter part of April, the lice hatch and make their way in large numbers to the green ends of the opening buds. At birth the creatures are of a very dark green color, but they become lighter as they attain full size. The aphides are at first wingless, but about the first week in June in western New York, or two weeks later, in the more northern apple districts, winged females make their appearance, which migrate to other trees and extend the infestation. Winged and wingless females develop on the trees throughout the summer and, in favorable years for the breeding of the insects, brood after brood appears, each in turn producing other broods and giving rise to millions of these destructive pests. In November sexual forms of the lice appear on the trees. The male aphides are very small, pear-shaped, wingless creatures and are brownish, or pinkish in color. The egg-laying females are wingless and green in color. Both viviparous females and the sexual individuals may be found on apple foliage well into late autumn.

Oat-aphis.— This species is much smaller in size than the green apple-aphis and is lighter in color. The eggs are found on both apple and pear trees, and they hatch as the buds are expanding in the spring. Two or three generations of the females may develop on the trees, after which the lice migrate to grains or grasses where they breed until the autumn. At that period winged females migrate to apple or pear trees where sexual individuals soon appear and deposit eggs, which do not hatch until the spring. The lice usually disappear from bearing fruit trees before severe injuries occur, but in nursery plantings the foliage is often badly curled by the attacks of the aphis.

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[2] From a letter by Dr. C. Gordon Hewitt. Chief of Division of Entomology, Ottawa, Canada, dated January 16, 1915.

MODE OF ATTACK AND RESULTS ON PLANT.

Injuries from plant lice result chiefly from the extraction of plant juices by the insects which feed upon the foliage and fruits. In spite of their small size they are capable of doing as great damage as much larger species of insects, which may be explained by their peculiar habits. In the first place the potential rate of reproduction with these creatures is high, and when conditions are favorable for their various activities they multiply rapidly and soon reach prodigious numbers. Far from circulating from leaf to leaf, the apterous or wingless forms are, on the contrary, quite sedentary and live in colonies, the individuals in each assemblage being packed one against the other. They remain fixed on the same spot, with their rostra or sucking bills thrust in the foliage and fruit, from which they extract the juices of the delicate tissues. This irritation destroys the invaded plant cells and leads to a diseased state, which shows itself by the curling of the leaves and the characteristic deformation and dwarfing of the apples. Even if the fruit is not attacked the apples may be small and misshapen because of injuries to adjacent leaves. In the period immediately after blossoming, a few lice, strangely enough, suffice to leave their destructive impress on the clusters of apples and appear to be capable of inflicting greater harm than if the attacks were made at a later date. Why the early infestation by the pests is attended with more serious consequences than are later invasions has not been satisfactorily explained, but the injury is apparently correlated with the moisture supply to the fruits at their formative stage. In the period just following the dropping of the blossoms, the energy of the plant, so far as the development of the fruit is concerned, is directed primarily to the proper nourishment of the growing seeds and the adjacent parts. After two or three weeks the form of the fruit becomes fixed and is not noticeably influenced by the moisture supply thereafter. It goes without saying that myriads of plant lice must make a serious drain on the vital fluids of the fruit spurs. The diminished supply and retardation of circulation at the most critical period in the development of the young fruit would necessarily produce great physiological disturbances, and these are probably the chief factors responsible for the deformed and undersized fruits that so frequently accompany early and severe outbreaks of plant lice in apple orchards.

SUSCEPTIBILITY OF CERTAIN STAGES TO SPRAYING MIXTURES.

During the progress of their life cycle the apple aphides are at various periods vulnerable to applications of spraying mixtures. As a result several methods of spraying have been developed which are based on susceptibilities of certain stages of the insects to particular insecticides. The chief points of attack in the life of the aphides are:

1. In the winter or egg stage.
2. As eggs are hatching and the lice assemble on the green ends of opening buds.
3. At time of maturing of stem-mothers and first appearance of their young.
4. At time of appearance of fall migrants and egg-laying females on apple trees.

We may now inquire into the conditions under which the aphides are amenable to spraying at these respective stages, considering the foregoing points in the order as given.

(*1*) *Susceptibility of aphis eggs to spraying mixtures.*— Since the eggs of these aphides carry the insect through the winter they are considered by some writers a very vulnerable stage in the life of the insect. This belief is founded on the occurrence of the eggs of certain species in large numbers in exposed positions on the young wood, and especially on the results of some experiments, which need corroboration, that indicated that the ova were susceptible to various insecticides as lye, soap, oil emulsions and lime-sulphur solution. The advantages from this method of treatment, if it would stand the test, are the ease of thorough spraying because of freedom from interference from foliage and the destruction of the pests at the very outset, which effectually checks the multiplication of the lice, and in that event prevents early infestation of the leaf and fruit clusters. While the eggs of at least certain species of aphides are amenable to spraying it is by no means certain that the ova of the apple aphides in New York are susceptible to insecticides. In tests by the Geneva

Station in nursery blocks and in orchards of young apples the eggs of the green aphis were somewhat vulnerable to lime-sulphur preparations and oil emulsions, while in repeated spraying operations in old-bearing apple orchards applications of these insecticides to kill aphis eggs have proven of doubtful utility. The greater immunity of the eggs on old trees we have not been able to explain satisfactorily except on the supposition that more or less numbers of the eggs are protected by rough bark, and the great size of the trees makes thoroughness of spraying difficult.

(2) *Spraying for newly-hatched lice on opening buds.*— As previously indicated, the lice on hatching make their way from the positions where the eggs are deposited to the buds that are expanding and show green at the ends. This habit serves the insects two good purposes. First, the green tissues furnish the initial means of subsistence, and secondly the folds of the expanding leaves are the first to provide positions of concealment, as the creatures prefer cover for their destructive activities. This behavior of the insects is of special interest to the one attempting to combat them, since the effect of this early movement is to mass the insects on certain buds, where for a number of days they occupy positions that render them very susceptible to spraying mixtures. It is well within the bounds of truth to state that in no other stage of their lives are they so vulnerable to remedial measures. The lice are young and tender, and unlike the eggs or mature lice they offer very feeble resistance to common contact insecticides. As the newly-hatched lice are the progenitors of the many broods that are to come, it follows that the destruction of the lice on the expanding buds is a desirable achievement. Actual experience has shown that this is the most effective and satisfactory means of avoiding injuries as the operation for the most part protects the foliage and the young fruit in its formative or most delicate stage.

(3) *Spraying for stem-mothers and their young.*— Individuals of these stages are susceptible to contact sprays. Production of young by the stem-mothers occurs during the period extending from the appearance of color in the unopened blossoms to the dropping of the petals. A serious drawback to spraying at this advanced season is that more or less numbers of the leaves may be rolled, and if infestation is severe and the leaves are badly curled most fruit growers fail to derive any benefit from their spraying operations

because of the difficulty in reaching appreciable numbers of the insects.

(4) *Destruction of fall migrants and egg-laying females.*— These stages of the insect have received little attention as regards their susceptibilities to spraying mixtures. The object to be attained by the destruction of fall migrants and egg-laying females is that timely spraying would prevent oviposition. If no eggs were laid on the trees there would be, according to our present state of knowledge, no insects during the following spring and early summer to infest the fruit and leaf clusters. It is desired to record at this time that the Geneva Station has been working along this line, and whenever the applications have been carefully timed deposition of eggs has been completely prevented. Satisfactory control of the insects by spraying at this season is however attended by practical difficulties, which are not likely to prove easy for the commercial grower to overcome.

STATION EXPERIMENTS.

The work of the Geneva Station against apple aphides may be discussed under two headings: The Station's Experiments and Farmers' Co-operative Experiments. Through the courtesy of Commissioner Calvin J. Huson, the latter were largely under the immediate supervision of Mr. L. F. Strickland, nursery inspector for Niagara county, and Mr. A. B. Buchholz, nursery inspector for Orleans county. These various activities are briefly summarized as follows:

THE STATION'S EXPERIMENTS.

Preliminary experiments.— From 1905 to 1911 a series of experiments with a large number of spraying mixtures, singly or in combination, were conducted in the orchard of Mr. J. S. Beckwith, New Haven, Oswego County, and in the various plantings of apples on the Station's grounds to determine under what conditions the aphides were most amenable to spraying. The results, in brief, demonstrated the great difficulty of accomplishing much of value when many of the leaves were curled, because of the difficulty of reaching the greater proportion of the lice, and the inability of the young apples that were attacked early to recover from the injuries received. The conclusion drawn from our experiments was that if any real benefit is to be derived by spraying, the applications should be made before the "baby" apples have sustained any injuries; either by

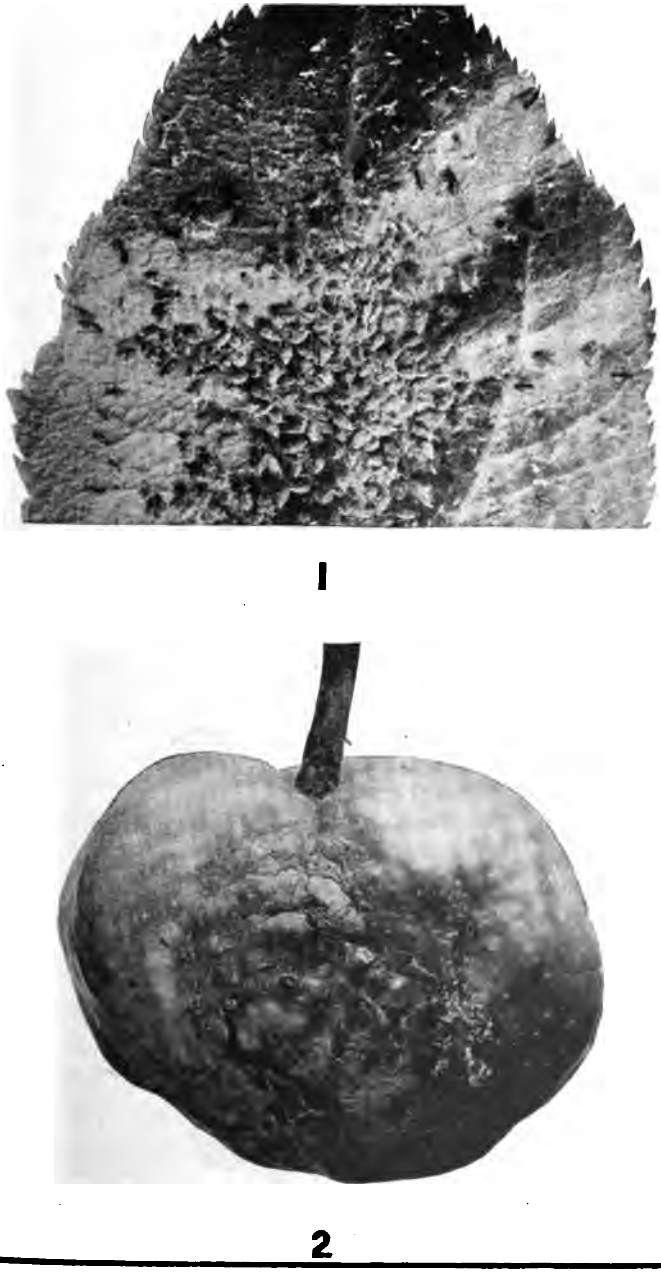

Plate XXII.— Work of the Rosy Aphis.
1, Colony on under surface of leaf; 2, Apple deformed as result of aphis work.

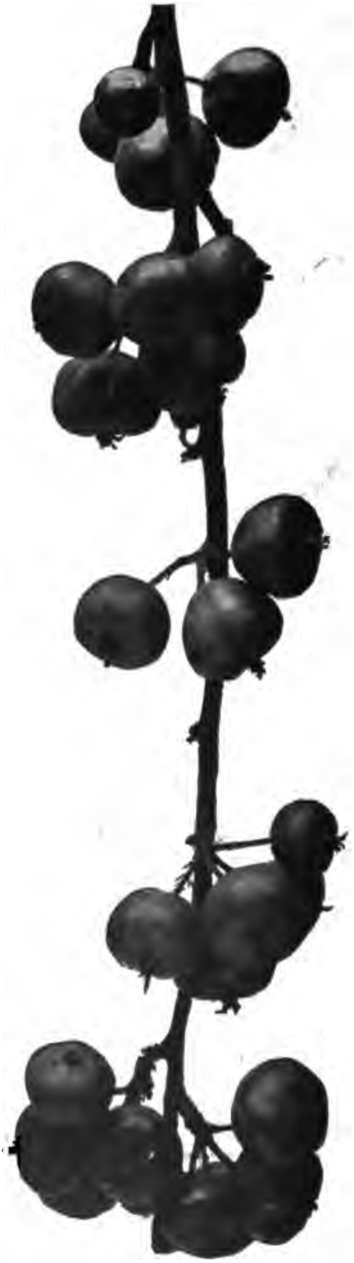

PLATE XXIII.— DEFOLIATION AND CLUSTERS OF SMALL DEFORMED APPLES DUE TO ROSY APHIS.

spraying when the buds are breaking and the lice are assembled on the green tips, or by spraying about the time of the maturing of the creatures just before or after blossoming. Succeeding efforts were, therefore, largely directed in ascertaining the relative susceptibilities of these stages in the life of the aphides to spraying mixtures.

Experiments during 1912.— During this year seven experiments were made in apple orchards of the following growers:

Frank E. Bacon, Albion, 400 trees, 45 years.
Lynn M. Burrows, Albion, 269 trees, 30 years.
John Larwood, Albion, 350 trees, 45 years.
Harry B. Gibson, Albion, 98 trees, 37 years.
160 trees, 20 years.
Willis Weaver, Kent, 200 trees, 43 years.
William Bugbee, Gasport, 180 trees, 40 years.
Chas. Dunkelberger, Gasport, 396 trees, 30–45 years.

These plantings were sprayed on April 25 and 26, at which time the blossom buds were showing green at the tips and were thickly covered with lice, especially the oat aphis. A nicotine preparation, 40 per ct., was combined with lime-sulphur solution at winter strength. All trees that were carefully sprayed were rendered practically free of the insects. Unfortunately as the season advanced conditions were not favorable for the development of the aphides so that the experiments gave only negative results.

On May 2 and 3 tests similar to the above were conducted in the orchards of the Albert Wood Estate, Carlton; Chas. Dunkelberger, Gasport, and F. E. Hanlon, Medina. On this date the aphides had worked deeply into the buds. In spite of this protection, a large reduction in the numbers of the aphides was secured wherever the applications were thorough. Owing to the disappearance of the lice from sprayed and unsprayed trees within three weeks after the time of treatment, the experiments proved inconclusive.

Experiments during 1913.— The experiments for this year were limited to two orchards of the following growers:

Wm. Smith, Albion, 65 trees, 35 years old.
H. H. Freeman, Albion, 234 trees, 30 years old.

Spraying with nicotine solution in lime-sulphur when buds were green at the ends destroyed over 95 per ct. of the lice, which were mostly the oat aphis, with scattering numbers of the green and rosy aphides. The oat aphis subsequently disappeared from the orchards, but the green aphis, after causing more or less serious curling of foliage of the unsprayed trees, left the leaf clusters of the fruit spurs and bred for the remainder of the season on the water sprouts. The experimental plats receiving the bud treatment were not appreciably affected with either the green or rosy aphis during the remainder of the season, although there were more or less of the green aphis on the water sprouts of some of the trees.

Tests with the same spray after blossoms dropped killed a goodly percentage of the insects, and while the trees receiving this late application presented better conditions than the checks, they were unmistakably inferior in appearance to those that were given the bud treatment.

Experiments during 1914.— During this year experiments were conducted in the orchards of:

H. H. Freeman, Kent, 9 trees, 40 years old.
A. H. Ernest, Lockport, 133 trees, 30 years old.

In the Freeman orchard three trees were sprayed as buds were breaking, three trees before blossoming and three trees as petals dropped from the trees. In each case nicotine solution was used with lime-sulphur mixture. The only treatment that really gave satisfactory results was the spraying when buds were opening. As a result, the trees receiving this application were only slightly infested with the rosy aphis, while those receiving the later sprayings exhibited considerable injuries to both fruit and foliage.

In the Ernest orchard there were two plats; one was sprayed as the color showed in the blossom buds, and the other received treatment as the petals dropped from the trees. In each case it was difficult to detect any advantage gained from either of the treatments, as it was not possible to reach any appreciable numbers of the stem-mothers, which were well hidden in the curled leaves.

FARMERS' COOPERATIVE EXPERIMENTS.

Cooperative experiments during 1913 in Orleans county. — During this year experiments were conducted in nine orchards in Orleans county as follows:

Thomas Mack, Holley, 50 trees, 35 years old.
Geo. Smith, Lyndonville, 24 trees, 75 years old.
50 trees, 18 years old.
50 trees, 12 years old.

J. Swift, Lyndonville, 300 trees, 25 years old.
150 trees, 9–10 years old.
400 trees, 5 years old.
J. Bayne, Lyndonville, 300 trees, 30 years old.
A. J. Skinner, Knowlesville, 210 trees, 35 years old.
M. Bruinsmade, Lyndonville, 300 trees, 30 years old.
Albert Wood Estate, Carlton, 2927 trees, 12–50 years old.

With the exception of the first orchard, all the plantings were sprayed as the fruit buds showed green at the ends with nicotine solution in lime-sulphur for the most part or with soap solutions or oil emulsions to destroy principally the oat aphis, and scattering numbers of both the green and rosy aphis. These treatments effected an almost complete destruction of the insects. As a further precaution, another application was given the trees just before the opening of the blossoms by combining nicotine with lime-sulphur at summer strength, carrying arsenate of lead. As in the Station's tests for this year, the lice did not develop to destructive numbers, even on the unsprayed trees; so that in the main the results for the season were negative. But nevertheless, while the rosy and the green aphis were not present in any of the plantings in conspicuous numbers, still there were scattering colonies of both species; and with respect to these the contrast between sprayed and untreated trees was marked.

In the Mack orchard, the bud spraying was omitted and treatments were given the trees just before and after blossoming, the former application killing about 75 per ct. of the aphides, and the latter application about one-half of the remaining insects. This experience indicated that had the season been favorable for the development of the aphides the numbers of the creatures that survived the treatments were sufficient to cause serious damage. Unlike the preceding experiments, there was not a great deal of difference in the conditions of the sprayed and unsprayed plats.

Cooperative experiments during 1913 in Niagara County. — The experiments during this year were conducted in the orchards of:

Fred B. Kayner, Gasport, 300 trees, 30 years old.
E. F. Strickland, Akron, 1000 trees, 3–8 years old.
D. L. Priesch, Middleport, 500 trees, 12 years old.

These plantings were sprayed with lime-sulphur and nicotine solution on April 17, and during succeeding days, when the buds showed green at the ends, to combat principally the oat aphis. In the Kayner and Strickland orchards the insects were completely destroyed. While there was a marked contrast in the conditions of the treated and untreated trees with respect to the numbers of the insects for two weeks following the experiment, the results were negative as far as the green and rosy aphides were concerned, as neither of these species appeared on any of the trees in important numbers. In the Priesch orchard a test with fish-oil soap, 1-5, as leaves were unfolding proved quite ineffective in reducing the numbers of the oat aphis.

Cooperative experiments during 1914 in Niagara County.— During this year, spraying experiments were carried on in nine apple orchards of the following growers:

J. A. McAuley, Lockport, 23 trees, 35 years old.
Floyd Cothran, Lockport, 60 trees, 30 years old.
Richard Taylor, Lockport, 2,000 trees, 35–70 years old.
W. E. Wiseman, Lockport, 200 trees, 36 years old.
Fred Zimmerman, Lockport, 646 trees, 28 years old.
Ralph E. Heard, Lockport, 1,100 trees, 12–25 years old.
A. A. Fonner, Lockport, 150 trees, 40 years old.
H. J. Treichler, Sanborn, 11 trees, 36 years old.
H. B. Treichler & Son, Sanborn, 85 trees, 40 years old.

In none of the various experiments were the results more striking or conclusive than those attending a thorough spraying of the trees at the time when the fruit buds were showing green at the ends. As the season's experience constitutes a noteworthy chapter in the history of our efforts to develop and to establish more efficient spraying practices, the experimental activities in five orchards may properly be discussed with some detail.

BUD SPRAYING EXPERIMENTS.

Orchard of J. A. McAuley.— In this orchard the trees were sprayed while the fruit buds were compact but the young leaves were beginning to unfold. The spraying mixture was nicotine solution, 40 per ct. in combination with lime-sulphur. On May 11 the check row of trees was badly infested with the aphides, while on the treated plats there were only occasional colonies of the insects. On June 4 the conditions of the sprayed trees were unchanged, while the checks were much infested with the rosy aphis, showing extensive curling of the foliage and many stunted apples. At the time of harvesting the owner reported that the checks, while carrying a great many apples, actually produced only two bushels of marketable fruit per tree. The sprayed trees approximated fifteen barrels each of saleable fruit.

It is of added interest to note than on the day following the treatment of the experimental plat the owner sprayed the remainder of his planting without supervision. The effect was to cause a great reduction in the numbers of the insects. On June 6 the young apples generally showed evidences of being stunted, as a result of which there was a large decrease in the amount of marketable apples on the unsprayed trees. On the other hand, with sprayed portions of the orchard there was no appreciable loss to the crop as a result of aphis injuries.

Orchard of Floyd Cothran.— The main portion of this planting was sprayed with nicotine solution, combined with lime-sulphur, as the tips of the buds showed green. On May 11 the checks were much infested with the lice, while the sprayed plats showed only scattering colonies of the insects. On June 4, the rosy aphis was abundant on the untreated trees, but in striking contrast to these the treated trees were practically exempt from the insects, showing little injury to either fruit or foliage.

Orchard of Richard Taylor. — The entire orchard, comprising 2,000 trees, was sprayed with nicotine solution in lime-sulphur at winter strength as buds showed green ends. The aphides were present in large numbers, consisting principally of the oat aphis, with which there were intermingled few specimens of the green and rosy aphides. One tree was left as check, which was severely infested by the rosy aphis. It should be noted that the treatment destroyed a high percentage of the insects, and that while adjacent orchards suffered severely from the rosy aphis the trees in these plantings to a large extent escaped unscathed by the lice.

Orchard of W. E. Wiseman.— As the buds were showing green, all of the trees, no checks being reserved, were sprayed with nicotine solution in lime-sulphur solution. Very few aphides survived the application. While surrounding orchards, including another planting of the owner, suffered severely from the rosy aphis, there was no appreciable damage to the crop of the sprayed trees.

Orchard of H. B. Treichler and Son.— In this orchard fifty trees, about forty years old, were sprayed with nicotine solution as the buds were breaking. On May 21 and again on June 17, examinations of the treated trees revealed only an occasional aphis; while on these dates the insects were abundant on checks and by June 17 had caused much damage to fruit and foliage, with promise of greater injury.

SPRAYING JUST BEFORE BLOOM.

In two orchards 67 large apple trees were sprayed just before blossoming with nicotine solution in lime-sulphur mixture. The spray was used in liberal quantities and much care was exercised to wet thoroughly both foliage and fruit clusters. In neither case was any appreciable benefit derived, and as far as one could judge the sprayed trees were but little, if any, better than the checks, and all showed considerable damage to the fruit and foliage as a result of the injurious work of the rosy aphis.

SPRAYING AS PETALS DROP.

Experiments were conducted in three orchards, comprising 1896 apple trees ranging from 12 to 40 years of age, with nicotine solution in lime-sulphur mixture or with kerosene emulsion diluted with six parts of water. The applications were made within a period of ten days after blossoming. At this time the stem-mothers had matured and large numbers of lice of the second generation were appearing on the foliage. In some instances a goodly percentage of the aphides were killed by either spray but, considering the work as a whole, the results were not satisfactory because of the stunted conditions of many of the young apples, the extent of curling of the leaves and the numbers of the lice that escaped the applications.

COMPARISON OF STATION'S CONCLUSIONS WITH SPRAYING PRACTICES IN OTHER STATES.

With the rapid extension and development of orcharding, the lice discussed in this article have become serious pests also in other apple-growing sections of the United States, and with advancing years have threatened increasing loss and destruction. In view of the results of our experiments it was desired to know how our conclusions compared with those of professional entomologists and practical workers in other states who have been seriously engaged in developing more efficient spraying practices against the apple aphides. To this end a questionnaire was widely circulated in which four questions among others bearing on the susceptibility of the insects to standard spraying mixtures were submitted, as follows:

(1) In your experience have spraying operations directed to the destruction of aphis eggs afforded protection to bearing apple trees?

Of 31 replies, 9 answered "yes;" 15 answered "no," and 7 answered "only partial success."

(2) Have you been able to control the aphides when appreciable numbers of the leaves have been curled?

Of 34 replies, 4 answered "yes," 23 answered "no," and 7 had no data on which to make a statement.

(3) Has spraying when the lice are assembled on the green ends of the expanding buds proven satisfactory? (b) Have supplementary treatments been required?

(a) Of 34 replies, 4 answered "no," 23 answered "yes," and 7 had not sprayed during that period.

(b) Of 34 replies, 5 answered "yes," 22 answered "no," and 7 were without experience on this treatment.

(4) What spraying mixtures have in your experience proven the most satisfactory?

Of 34 replies, 4 recommended for control of the aphides, kerosene emulsion; 21 recommended nicotine preparations; 1 recommended soap and lye, and 1 recommended soap. For destruction of the eggs, 7 advised lime-sulphur at winter strength.

METHOD OF TREATMENT.

FORMULAS FOR SPRAYING MIXTURES.

FORMULA I, NICOTINE SOLUTION.

Nicotine solution 40 per ct.	¾ pt.
Water	100 gals.
Soap	3 to 5 lbs.

This mixture will cost about $1.15 per 100 gallons. In combining nicotine solution with lime-sulphur omit the soap.

FORMULA 2, KEROSENE EMULSION.

Kerosene	2 gals.
Fish-oil soap	½ lb.
Soft water	1 gal.

Directions for making kerosene emulsion are as follows:

Dissolve the soap, which has been finely divided, in one gallon of boiling water. Remove the vessel from the stove and add the oil. Then agitate the mixture violently for from three to five minutes by pumping into itself under high pressure until a creamy mass is formed, from which the oil does not separate. Fruit growers are advised not to employ an emulsion which shows a separation of the oil as application of such preparations may cause injuries to the trees. This is used with success by some growers for summer spraying against the lice at a dilution of one gallon of the emulsion to eight gallons of water. This emulsion, when diluted as recommended, will cost about $1.08 per 100 gallons.

FORMULA 3, FISH OIL SOAP.

Fish oil soap	12 to 20 lbs.
Water	100 gals.

To prepare for use, slice the soap and dissolve in boiling water. Soap varies greatly in its water content, and before undertaking extensive operations the grower should make a preliminary test to determine the amount of material required to make an efficient spray. Soap used in the proportions as given will cost from 75 cents to $1.20 per 100 gallons.

COMBINATIONS OF SPRAYING MATERIALS.

Many pests of fruit trees pursue their injurious activities at similar periods of time and some of them are jointly susceptible to a single application of an insecticide or to a combination of spraying materials. As the expense of insecticides is usually much less than the cost of labor and team, it is desirable from the standpoint of economy and time to reduce the number of applications to the minimum. One means to this end is to employ combination mixtures or, as they are popularly called "two in one" or "three in one" sprays, according to the number and nature of constituents contained in them.

From the standpoint of safety to expanding buds and leaf tissues, and effectiveness against insects, the most satisfactory combination is three-fourths of a pint of nicotine solution (40 per ct.) to lime-sulphur solution at winter strength for bud treatment, or to lime-sulphur at summer strength with arsenate of lead for foliage applications. While this combination lacks somewhat the spreading properties of soap mixtures, oil emulsions or of nicotine with soap, this deficiency is probably more than compensated by the saving in labor in avoiding an extra application and by the thoroughness of spraying in the bud treatment when lime-sulphur is directed also against the San Jose scale.

Sodium and potassium sulphides may be combined with soap or oil emulsions, but they should be regarded as experimental mixtures until there is more knowledge of their insecticidal properties and of the effects of strong preparations of these sulphides on leaf and fruit tissues, especially in combination with common arsenicals.

DIRECTIONS FOR SPRAYING.

Bud spraying.— On the basis of the experiments previously described the most effective means of combating the lice is a thorough spraying of the trees at the time when the insects are assembled on the tips of the buds showing green and while the buds are compact. As the creatures that appear on the opening buds are the progenitors of many broods that are to follow, and constitute the first and only

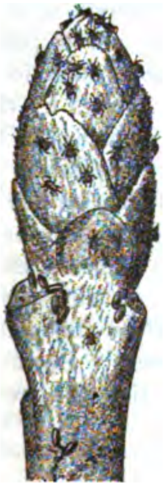

FIG. 7.—APHIDES ON OPENING BUDS; PERIOD FOR FIRST SPRAYING.

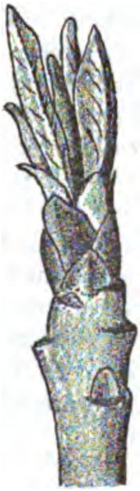

FIG. 8.—APPLE BUDS TOO FAR ADVANCED FOR EFFICIENT SPRAYING.

forms that infest leaf and fruit clusters at this period, special efforts should be made to allow as few as possible of the insects to escape this treatment. It should, therefore, be the aim of the orchardist to kill all of the insects, and work so directed will destroy from 95 to 98 per ct. of the creatures. To this end apply the spraying mixture in liberal quantities and under high pressures, endeavoring to wet all of the buds.

A word of caution as to timing of spraying operations.— It is common knowledge that varieties differ as to the time of opening of buds, and that trees of the same variety may show retarded or accelerated growth, according to the conditions of their environment. For these reasons the grower needs to take into consideration the stages of growth of the different varieties, waiting until the lice are massed on the opening buds and keeping in mind the importance of killing the insects before they obtain protection in fuzzy, unfolding leaves of the opening buds.

Later applications.— The grower should endeavor to combat the pest by the foregoing measures and thus avoid, if possible, the necessity of later sprayings. There are serious objections to late applications because of the danger of early injuries by the insects to fruit and leaf clusters and the difficulty of reaching the lice in the curled leaves, which becomes greater as the infestation increases. If bud treatment has been omitted or this application has not given entirely satisfactory results, one should spray with one of the foregoing mixtures as soon as the aphides are detected in numbers, endeavoring by high pressures to reach as many of the creatures as possible. The amount of protection that will be gained by this spraying will not prove as great as that of the early treatment. However, it will afford some measure of relief and perhaps tide the trees over a critical period.

THE CHERRY AND HAWTHORN SAWFLY LEAF-MINER.*

P. J. PARROTT AND B. B. FULTON.

SUMMARY.

During recent years sour cherries, principally of the variety English Morello, have exhibited a disorder of foliage which is characterized by light-colored blister-like areas, revealing a loss of chlorophyl, that are due to the destruction of the pulpy tissues. Studies by this Station show that this injury is caused by a leaf-mining hymenopteron (*Profenusa collaris* Mac Gillivray). This is a new orchard pest in New York and one not heretofore recorded as injurious to fruit plantings in this country. It was first reported from a cherry orchard near Geneva, N. Y., during the summer of 1910, and has since been found in injurious numbers in cherry plantings about Germantown, in the Hudson River Valley. It doubtless occurs in other localities. As a hawthorn pest the sawfly is definitely known to occur in New York and Massachusetts.

The adult insect is a small sawfly which varies from one-eighth to one-sixth of an inch in length. The body of the female is metallic black, with the prothorax rufous in color. The flies make their appearance during early May, at which period the first leaf clusters are unfolding and the blossom buds are beginning to open. The eggs are laid singly through incisions in the upper epidermis, and the lower surface of the egg usually lies in contact with the lower epidermis, which has been cut free from other tissues of the leaf so as to form a small blister-like cavity or pocket. The majority of the eggs are deposited in the basal portion of cherry leaves. Hatching occurs during the middle or the latter portion of May. The young larva works its way to the parenchyma immediately beneath the epidermis of the upper surface of the leaf and mines towards the distal end of the leaf, generally keeping close to the margin. The injury is first indicated by a small, sinuous channel, which finally swells out into a large, blister-like area. The blisters are very conspicuous on the upper surface of the leaves during early June, at which time the larvæ are making their maximum growth.

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* A reprint of Bulletin No. 411, December, 1915.

With the completion of their mining operations, about the middle of June, the larvæ abandon the foliage, bury themselves in the ground and construct an earthen cell. The insect passes the winter in the larval stage. Pupation occurs during the latter portion of April or during early May.

The injury to cherries by this species is due to the work of the larvæ which mine the leaves and destroy the mesophyl or pulpy tissues. Frequently the entire leaf is mined, but usually only from one-quarter to one-half of the leaf area is destroyed. The leaves that are most seriously affected shrivel and die, and finally drop to the ground. The damage is largely confined to the foliage that unfolds with the bursting of the buds. The extent of damage with cherries varies in importance according to the extent of infestation and influence of seasonal conditions on the rate of growth. Injuries to foliage of certain species of Cratægus are generally more severe than with cherries, and in certain localities have greatly reduced the attractiveness of these hawthorns for ornamental purposes.

The leaf-miner is subject to attack by two species of hymenopterous parasites which, during some seasons, have greatly lessened the numbers of their host. An ichneumon (*Pezoporus* (*Schenkia*) *tenthredinarum* Rohwer) has been collected in cherry plantings, while a chalcidid (*Trichogramma minutum* Riley) has been reared from eggs of the sawfly deposited in foliage of cherry and hawthorn.

In experiments to check the mining of cherry leaves the larvæ of the sawfly proved to be very resistant to lime-sulphur solution, napthalene, kerosene emulsion, miscible oil, nicotine solution, kerosene, or gasoline. Picking of affected leaves at first appearance of injury and destruction of hawthorns in the vicinity of cherry orchards are advised tentatively as the most practical means of avoiding injuries to cherries by the leaf-miner. Ploughing and cultivation, especially during late April or early May, would doubtless destroy many of the insects in the ground, although the exact value of this practice has not been determined. Fumigation with hydrocyanic-acid gas proved to be the only direct treatment of the foliage which effectually checked the destructive work of the larvæ in cherry leaves. An application of nicotine solution and soap when the young larvæ are beginning to tunnel the foliage apparently affords efficient protection to hawthorns.

INTRODUCTION.

In comparison with other fruits, sour cherries are singularly free from attacks by injurious insects. They are practically immune to the San José scale and generally are not much troubled with the plum curculio or plant lice, all of which are very destructive pests to other stone fruits, such as sweet cherries, plums or peaches. Of the pests that attack them, those of the greatest commercial importance in the State of New York are the cherry fruit flies (*Rhagoletis cingulata* and *R. fausta*) which cause maggoty fruit; the fruit-tree bark-beetle (*Scolytus rugulosus*) which burrows into the bark and wood of the branches and trunks; and the pear slug (*Caliroa cerasi*) which skeletonizes the leaves.

The comparative immunity which sour cherries have enjoyed from defoliating insects is now threatened by a leaf-mining hymenopteron which, in certain plantings of English Morello, has become quite prominent in recent years. The studies herein recorded were undertaken for the purpose of ascertaining the life history, habits and economy of the creature which, at the inception of the investigation, proved to be an unknown species and of rather widespread distribution.

HISTORY, BIOLOGY AND WORK OF INSECT.

DISCOVERY AND IDENTIFICATION.

The existence in the State of New York of a leaf-miner attacking cherry foliage was brought to the attention of the Experiment Station by the receipt of affected foliage during the latter part of June, 1910. An examination of the orchard from which the material had been collected showed that more or less of the leaves on nearly all of the trees of a variety known as English Morello had shriveled and died, while here and there were others with well-defined light-colored areas or blisters, revealing a loss of chlorophyl. Siftings of earth from beneath the trees showed that the causal agent was the larva of a species of sawfly. A number of these were carried through successive stages of development to the following year, when adults were obtained. Some specimens were forwarded to Dr. A. D.

MacGillivray,[1] formerly of Cornell University, who reported that the insect represented a new species, the type of a new genus, and should be recorded as *Profenusa collaris*. The information was also given that a small collection of the creatures reared from hawthorns growing about Boston, Massachusetts, had previously been received by him but the material was in too unsatisfactory a condition to describe. For popular usage we have proposed the name "The Cherry and Hawthorn Sawfly Leaf-Miner."

HOST PLANTS.

According to present knowledge the host plants of the leaf-miner are the cherry and the hawthorn. Of the cherries it has so far largely confined its attacks to the variety known as English Morello. It is not commonly observed on the Montmorency or Early Richmond, which would indicate that its presence on these varieties is accidental and occurs when these sorts are grown in close proximity to the Morello. The susceptibility of one fruit and the apparent unattractiveness or resistance to the insect of the other fruits are curious facts, since all are cultivated varieties of the same cherry, *Prunus cerasus;* and plantings of each kind, growing side by side, may be frequently observed in this State. The two sorts Montmorency and English Morello represent groups of cherries which vary more or less in both tree and fruit, but have a constant difference only in a single character — the juice in the fruits of one is colorless, in the other it is red. This sharp discrimination on the part of the leaf-miner seems all the more anomalous when considered in the light of its extreme partiality to the foliage of certain hawthorns, which are only remotely related to the cherry.

In its attacks on hawthorns the leaf-miner tunnels the foliage in the same fashion as that of the cherry. During the course of our studies it has been very evident that the pest is more destructive to certain species of Cratægus than it is to the cherry. As has been rarely observed with the cherry, one may find as many as five larvæ mining a single leaf. With hawthorns having a relatively small and narrow leaf, as *Geneseensis*, there may be an entire destruction of the pulpy tissues, in which event all that remains of the affected leaf is the epidermis, which dries up and ultimately falls to the ground. At the height of an attack, which occurs when the larvæ are reaching maturity, hawthorns which are much infested take on a brownish cast and appear as if struck by a blight or swept by fire. The destructive work of the insect may seriously mar the attractiveness of certain species of hawthorns as ornamental shrubs.

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[1] Letter, dated June 2, 1911.

About Geneva the leaf-miner is most common in the foliage of an unidentified hawthorn belonging to the Medioximæ group, while such species as *C. pedicellata* and *C. punctata*, growing in the immediate vicinity of the former, have so far shown little or no injury and are generally exempt from attack. Dr. C. S. Sargent, Director of the Arnold Arboretum, writes that the insect has become established in the Cratægus plantings and that it is especially destructive to hawthorns of the Crus-Galli group and *C. nitida*, *C. rotundifolia*, *C. pruinosa* and other species. Similar conditions exist at the New York Botanical Garden and, as elsewhere, certain species of Cratægus are pretty badly infested, while a few species have so far been free from attack.

In the public parks at Rochester, notably Genesee Park, the insect has in recent years become a serious pest. Hawthorns representing a wide range of species and grown in extensive numbers feature prominently in certain landscape plantings. In these the leaf-miner has become established and its destructiveness may be readily observed during May and June. Some haws have been seriously affected, while others have been exempt from injury. Here again various hawthorns of the Crus-Galli group have proven very susceptible to the pest, and certain species of other groups have shown considerable injury. It is not yet clearly demonstrated in all cases whether freedom from the pest is a matter of chance or that some species are actually immune to the insect. Through the courtesy of Mr. John Dunbar, assistant superintendent of parks, a recognized authority in the systematic knowledge of the Crataegi, an examination was made during June, 1915, of the hawthorns in the arboretum and the condition of the plants with reference to the work of the leaf-miner were noted. The accompanying list indicates the relative importance of the insect during the past summer to various hawthorns of different groups:

SPECIES MUCH INFESTED.

Name of Species	Group
1. *Cratægus* sp.?	Coccineæ
2. *Cratægus* sp.?	"
3. *Cratægus Brunetiana*	Rotundifoliæ

SPECIES MUCH INFESTED (*continued*)

Name of Species	Group
4. *Cratægus Geneseensis*	Crus-Galli
5. " *persimilis*	"
6. " *Bartramiana*	"
7. " *Engelmanni*	"
8. " *erecta*	"
9. *Cratægus fertilis*	Tomentosæ
10. " sp.?	"
11. *Cratægus* sp.?	Medioximæ

SPECIES SLIGHTLY INFESTED.

12. *Cratægus sera*	Molles
13. *Cratægus Lennoniana*	Pruinosæ
14. " *inusitula*	"
15. " *perjuncta*	"
16. *Cratægus tardipes*	Coccineæ
17. " *Thayeri*	"
18. " sp.?	"
19. *Cratægus Boothiana*	Tenuifoliæ
20. " *Streeteræ*	"
21. *Cratægus rotundifoliæ*	Rotundifoliæ
22. " *audita*	"
23. " *Jackii*	"
24. *Cratægus* sp.? No. 594	Tomentosæ
25. " sp.?	"
26. " *ferentaria*	"
27. " *spinulosa*	"
28. *Cratægus aprica*	Flavæ
29. *Cratægus dissona*	Medioximæ
30. *Cratægus Dunbari*	Anomalæ
31. *Cratægus nigra*	Pentagynæ

SPECIES NOT INJURED.

32. *Cratægus mollis*	Molles
33. " *submollis*	"
34. " *Arnoldiana*	"
35. *Cratægus Holmesiana*	Coccineæ
36. *Cratægus fucosa*	Medioximæ
37. *Cratægus chlorosarca*	Sanguineæ
38. *Cratægus* spp.	Intricatæ

DISTRIBUTION.

As a cherry pest the leaf-miner is definitely known to occur in injurious numbers in orchards of English Morello about Geneva in western New York and about Germantown, which is located in the Hudson Valley. It has been reported[2] to the Station as occurring about Schenectady, but the statement of its presence in that locality has not been verified. In view of its occurrence in two communities which are widely separated, it would seem reasonable to suppose that the pest exists in other localities where sour cherries are extensively grown. However, a careful survey by the orchard and nursery inspectors of the Department of Agriculture in all of the leading fruit-growing counties of the State has failed to find any evidences of the work of the insect except in the foregoing localities. A study of available literature indicates that the insect is not known to occur as a cherry pest outside the State of New York.

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[2] Proc. W. N. Y. Hort. Soc. for 1912, p. 122.

As a depredator of hawthorns the leaf-miner has a wider range of distribution. It is known, as already indicated, as a serious pest of hawthorns growing about Boston, Mass., and it is common on various species of Cratægus growing in the vicinity of New York City, Rochester, Ithaca, Geneva and Skaneateles, all of which are located in this State.

APPEARANCE OF THE INJURY.

As implied by its common name, the insect is a leaf-mining species and its work is very characteristic. The injury is first indicated by a small, thin, sinuous channel which finally swells out into a large blister-like area of a light brown shade resembling that of dead leaf tissues (Plate XXVIII). The attack by the larva of the sawfly begins on the edge of the leaf toward the stem, and continues along one side toward the leaf apex, the tunnel increasing in dimensions with the growth in size and the progress of the insect. Upon reaching the tip of the leaf the grub reverses its course and works backward toward the stem, consuming the remainder of the pulpy tissues between the main rib and the margin of the leaf. As a result, the parenchyma or soft cellular tissue is eaten, leaving the epidermis, which turns brown and forms a large blister. These blisters are very conspicuous in the upper surfaces of the leaves. Oftentimes the whole leaf is mined, but usually one-quarter to one-half of the whole area of a leaf is destroyed. Only the leaves that first unfold are subject to attack, but during some seasons hardly any of these escape the insect's depredations. The principal damage occurs during the last week of May and the early part of June or about one month before the harvesting of the fruit. With the disappearance of the larvæ the leaves most seriously affected shrivel and die, and finally drop to the ground, causing defoliation which varies in importance according to the extent of infestation and the influence of seasonal conditions on the rate of growth. The actual effect of the work of the insect upon the crop is not easily measured and, during most years, is perhaps not of serious extent. However, as previously indicated, the destructive power of the pest is mainly exercised on the leaves that unfold with the bursting of the buds. In years of slight precipitation and when new growth is of small extent and of slow development the plant is dependent on such foliage as it carries at the time, and any extended injury to it must result in a set-back, with corresponding ill effects on the maturing crop of fruit. In years when the production of new growth is more rapid the damage caused by the sawfly is of much less importance as the large leaf surface under the circumstances is sufficient for the needs of the plant and the loss of affected foliage does not result in an important reduction in leaf area.

The hawthorns are more subject to severe attacks than the Morello cherry, and during some seasons plants may be observed on which there is hardly a leaf that does not show injury. Notwithstanding the partiality of the sawfly for this plant, hawthorns seem able to withstand considerable destruction of foliage without marked external evidences of the weakening of the trees. As shown in Plate XXIX, the attractiveness of the plants as ornamental shrubs may be seriously marred.

BIOLOGY OF THE INSECT.

The Tenthredinoidea, to which this species belongs, constitute a large and important group of hymenopterous insects, including some very destructive forms, as the pear slug (*Caliroa cerasi* Linn.), the rose sawfly (*Endelomyia rosæ* Harr.) and the currant worm (*Pteronus ribesii* Scopoli). It is estimated that there belong to this superfamily about two thousand species, and according to Dr. MacGillivray[3] seven hundred or more species are recorded for this country. Of these occurring in the United States probably not more than five to eight per ct. are of sufficient economic importance to be classed as injurious insects. The adults are very much alike, and in spite of their numbers few species only attract the attention of the general observer; and these almost solely because of the destructive role of the larvæ. The vernacular name bestowed on these insects originated doubtless from the fact that the ovipositor of the female is a cutting organ, operating in much the fashion of a saw. This is composed of two small chitinous structures, finely serrated, which lie side by side and may be projected from a protective sheath and moved up and down with a saw-like motion. These saws are employed to lacerate vegetable tissues and form apertures or pockets in the plant substance where the eggs are placed. The larvæ reveal great similarities in their more important characters of structure and habit. Some forms, as the pear slug, are covered with a slimy secretion and pass more easily for slugs than insect larvæ; others are coated with a waxy substance which may completely conceal their identity; while many, such as the rose and currant species, resemble caterpillars and feed in exposed positions and on a great variety of plants. A number of species reside in galls, while a few forms are leaf-miners. When mature the larvæ of most species descend to the surface of the ground and spin cocoons about themselves.

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[3] Letter of Sept. 20, 1914.

DESCRIPTION OF LIFE STAGES.

Egg.— The egg (Fig. 9) is elliptical in shape, but is not entirely symmetrical in its outline, as one side shows a greater curvature than the other. It is, when removed from surrounding plant tissues, circular in cross section, but in its normal position in the leaf structures it is much flattened owing to pressure. The chorion is a thin, white, shining, flexible membrane. The measurements of eggs when not compressed are: Length, 0.5 to 0.7 millimeter; and diameter, 0.28 to 0.36 millimeter.

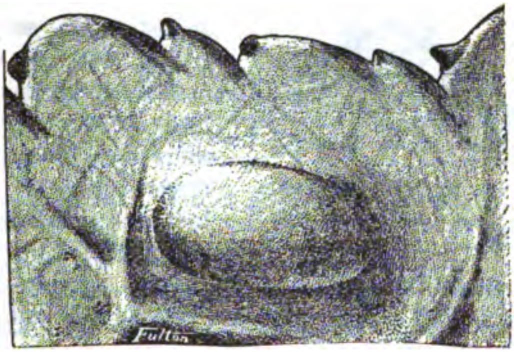

FIG. 9.— EGG OF SAWFLY LEAF-MINER IN MARGIN OF LEAF. (× 50)

Larva.— To determine the number of instars the mines were carefully examined for all insect remains, when the head molts were collected and measured as to width. The body remnants from some of the molts in first larval instars were occasionally missing, having probably been eaten, but in very few cases were the head structures not in good condition for purposes of examination. The width of the head is fairly constant for the first larval instar but in the more advanced stages there is considerable variation. On the basis of head measurements it appears that the larva normally molts five times in its mine. It finally enters the ground and molts again in transforming to a pupa.

The first five instars have the same general form and differ one from the other principally in size. The body is broadest at the first and second thoracic segments, and gradually tapers toward the rear. The thoracic legs are short and conical and are composed of five segments, which include the thick basal and the small hooked terminal structures. All the abdominal segments except the last bear short rounded prolegs on the ventral side. The head (Fig. 10) is horizontal in the early stages, but slopes downward slightly in later instars. It is broad and flat, rounded on the sides and obtuse in front. On the dorsal side it bears four longitudinal sutures. The outer pair run back from the ends of the clypeus and divide the head into three almost equal sections. The inner pair extend one-half way across the middle section, dividing it into three equal areas. Eyes are wanting. The antennæ are very short and are apparently composed of three segments. The maxillary palpi are large and protrude from beneath the head. The labial palpi are very small. The mandibles are short and thick, deeply hollowed on the inner side and do not protrude beyond the end of the broadly notched labrum.

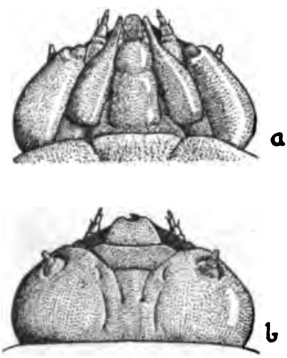

FIG. 10.— HEAD OF LARVA. a, Ventral side; b, Dorsal side

The technical description of each of the larval stages follows:

First instar. (Plate XXV, fig. 1).— Body translucent, white, shining; only slightly wrinkled, and with a green streak, due to alimentary tract, showing plainly in the abdominal segments. Prolegs appear as only slight elevations.

Head is slightly brownish, being of darker color on the outer and posterior edges; mouth parts are reddish brown. The ventral side of the first thoracic segment has a pair of brownish gray marks, shaped roughly like a T with the cross bar running longitudinally and the perpendicular reaching outward to a point just in front of the leg. A semicircular line of the same color occurs in front of the anus and is interrupted on the median line.

Newly-hatched larvæ are about 1.2 mm. in length, and after feeding the body grows, reaching a length of 2.3 mm. Width of head, 0.36 to 0.42 mm.; average, 0.39 mm.

Second instar. (Plate XXV, fig. 2).— All markings of body are more extensive than in preceding stage. Dorsal side with some specimens has a broad, faint, brownish-gray, transverse band on the first thoracic and two spots on the second thoracic segments. The pair of marks on ventral side of first thoracic segment are shaped more like inverted V's, and between them there is a large longitudinal band. The second and third segments have medium oval spots. Each proleg is marked by a narrow crescent on the anterior side. A semicircular mark on the last segment extends over half a circle and is not interrupted on the median line.

Length, 2.6 to 3.00 mm. Width of head, 0.48 to 0.55 mm.; average, 0.52 mm.

Third instar. (Plate XXV, fig. 3).— All markings are the same as in preceding stage, but are much fainter. Prolegs are more prominent; those on the first and penultimate abdominal segments are small.

Length, 3.2 to 4.3 mm. Width of head, 0.63 to 0.73 mm.; average, 0.67 mm.

Fourth instar. (Plate XXV, fig. 4).— The characteristic markings in preceding stages practically disappear in this instar. A ring of several rows of minute papillæ surrounds the anus. These probably exist in the earlier instars and escape detection because of their small size.

Length, 4.5 to 7.2 mm. Width of head, 0.8 to 0.9 mm.; average 0.85 mm.

Fifth instar. (Plate XXV, fig. 5).— This is similar to fourth instar. There are no distinct color markings.

Length, 6.5 to 7.5 mm. Width of head, 0.92 to 1.07 mm.; average, 1.0 mm.

Sixth instar. (Plate XXV, fig. 6).— The body does not differ from that of preceding stage. The head assumes a vertical position. The four sutures on the dorsal side are very faint. The clypeus and labrum are shorter than in fifth instar. The mandibles protrude prominently and do not meet at the ends. The labium and maxillæ project from beneath the head to beyond the tips of the mandibles.

Length is same as in fifth instar or may be a trifle shorter. Width of head, 0.90 to 1.05 mm.; average, 1.0 mm.

Pupa. (Plate XXV, fig. 7).— Until color of adult begins to show the pupa is white in all portions except the eyes, which are reddish. Length about 5 mm.

*Adult.** (Plate XXIV, figs. 1 and 2).—" Body of female black, with the clypeus, labrum, malar space, the mandibles, the first segment of the antennæ, the tegulæ, the narrow margin to the pronotum, and the legs, for the most part, whitish. The prothorax, except the parts named, the cephalic part of the mesopleuræ, and the pectus, rufous; the posterior femora more or less shaded with fuscous; the head smooth with antennal furrows interrupted on the middle of the face; the furrows surrounding the postocellar area deep and distinct; the vertical furrows not reaching the occiput; the median ocellus placed on a flat depression; a pit above the antennal socket; the median fovea minute but distinct; the clypeus truncate; the first and second antennal segments subequal, the third segment subequal to one and two together and longer than four; the saw-guides with the dorsal and ventral margins converging and the apex bluntly pointed.

The male differs in having the rufous part of the thorax inclined to whitish and extending over the entire pleuræ, the venter of the abdomen and a broad band on the lateral part of the dorsal aspect, broader behind, sometimes fused on the meson, whitish; the posterior femora not fuscous. Length, 3 to 4 mm."

ANATOMY OF REPRODUCTIVE ORGANS.

Ovipositor.— The ovipositor serves as a saw, and this organ is composed of two pairs of blades and a sheath, formed of a single pair of valves. It lies just posterior to the seventh abdominal sternum and is partly covered by the sides of the eighth and ninth terga. Each valve of the sheath is made up of three sclerites; a small triangular plate (Fig. 11, a, and Fig. 12, c) at the anterior end and hidden by the eighth tergum and a large elongated structure (Fig. 3, b, and Fig. 12, d) reaching from the seventh sternum to near the end of the body where it is hinged to the third sclerite (Fig. 3, c), which is a spoon-shaped plate that projects posteriorly and bears a number of hairs. The four blades of the saw are arranged in pairs, a lower and an upper pair, and as these structures are very thin and held in close contact with one another the bifid nature of each pair is not plainly apparent. The lower pair (Fig. 3, d, and Fig. 4, b) bears a number of teeth on the lower edge and really constitutes the saw proper. The upper pair (Fig. 11, e, and Fig. 12, a), which have a number of thickened crossbars and are joined together for a short distance on the upper edge opposite the proximal tooth of the saw, really serve as a support for the saw. The saw and this latter structure or support are connected along the edge by a tongue and groove joint, which permits one to slide on the other lengthwise (Fig. 12, e). At the base both pairs spread apart like the arms of a Y. The base of each blade consists of two thin chitinous rods, connected by a thin membrane. One of these basal rods of the support is continuous with the lower edge of its respective blade and fastens to the lower anterior angle of the large middle sclerite of the sheath (Fig. 4, g), while the other rod fastens along the anterior end of the same sclerite and con-

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*The original description copied from the *Can. Ent.* 46:364–366. 1914.

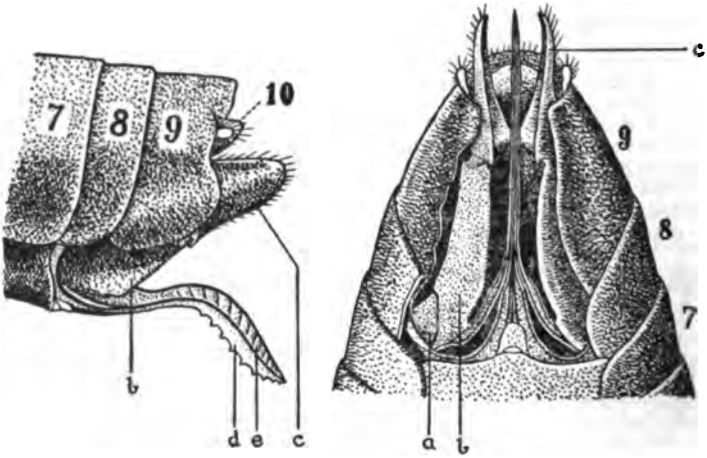

FIG. 11.— TIP OF ABDOMEN SHOWING OVIPOSITOR.
7, 8, 9 AND 10. Abdominal segments, seventh to tenth respectively; a, b, c, Three sclerites of ovipositor sheath; d, Lower blade of ovipositor; e, Upper blade of ovipositor.

tinues part way along the blade as a thickened rib (Fig. 4, f). The larger basal rod of the saw is continuous with its upper edge and passes clear around the anterior end of the sheath and fastens to the small triangular sclerite (Fig. 12, h). The smaller rod is continuous with the lower edge of the saw and fastens to the hind edge of the seventh sternum beneath a thin projecting median flap (Fig. 12, i).

Male genitalia.—The testes are small and are composed of a large number of rounded lobes (Fig. 13, a). The vasa deferentia are rather large and much coiled (Fig. 13, b). Each connects with a very large, saccate seminal vesicle, near its efferent end. (Fig. 13, c.) The ducts (Fig. 13, d, and Fig. 14, l) leading from the vesicles unite, forming the ejaculatory duct. (Fig. 13, f, and Fig. 14, j.)

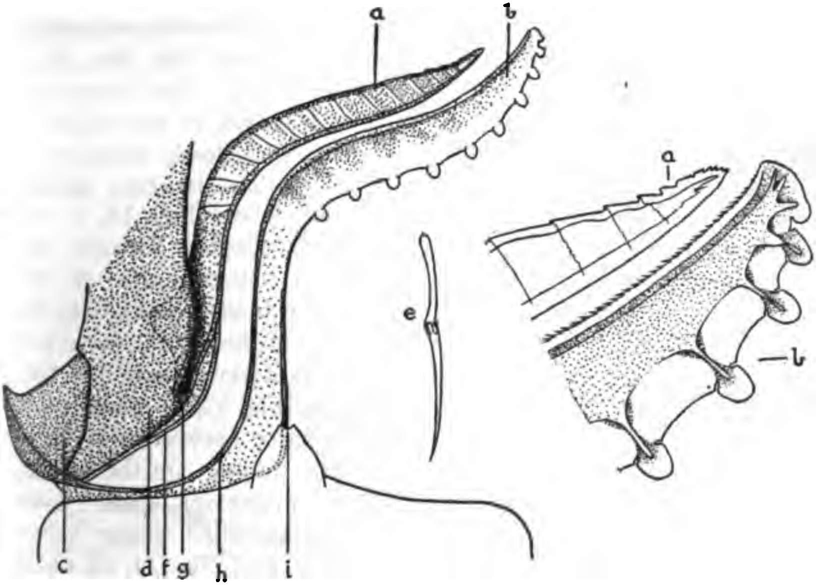

FIG. 12.— OVIPOSITOR.

a, b, Upper and lower blades of ovipositor, respectively; c, d, Two sclerites of the ovipositor sheath; e, Cross section of blades showing tongue and groove connection; f, g, Basal rods of upper blade; h, i, Basal rods of lower blade.

The external genital parts appear to be entirely derived from the tenth abdominal segment, which is drawn up in the tip of the abdomen and is completely protected from below by the large plate of the ninth abdominal sternum (Fig. 14, c). In general shape the genital armature is cylindrical and is flattened dorsoventrally. The base is oblique, the upper side extending farther anteriorly, and is bordered by a narrow chitinous ring (Fig. 13, e). The main body of the organ is made up of two large lateral valves (Fig. 13, h, and Fig. 14, f), whose bases are joined to the ring and are prolonged above and below so that they meet on the dorsal and ventral median line and form a complete circle. The end of each lateral valve bears a spoon-shaped movable flap on the lower side (Fig. 13, j, and Fig. 14, b). Just above the hinge of this flap, in the hollow of the valve and closely united to it there is another structure bearing two blunt lobes (Fig. 13, i, and Fig. 14, d) directed forward and inward. A narrow arm of the same piece extends inward from the upper edge of the lateral valve and forms the posterior margin of a thin membrane (Fig. 13, g) which roofs over the space between the upper edges of the valves. On the median line the membrane dips down between two small inner valves (Fig. 13, k, and Fig. 14, a) which constitute the penis, while the ejaculatory duct opens out at the bottom of this fold. The two inner valves are thin, concave on the inner side and reveal a flaring tip. These structures are in contact for a short space, but they spread apart at the outer and inner ends. During coition the outer ends are held close together forming a tube. The end of each valve is rodlike and has attached to it five muscles. Two of these originate on the dorsal part of the base of the outer valve and are attached to the middle and inner end of the rod (Fig. 14, i and k), serving to raise and lower the outer end respectively. Two

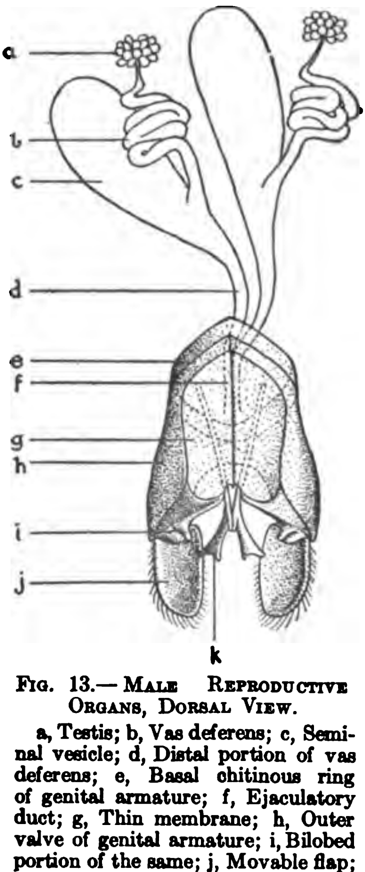

FIG. 13.— MALE REPRODUCTIVE ORGANS, DORSAL VIEW.

a, Testis; b, Vas deferens; c, Seminal vesicle; d, Distal portion of vas deferens; e, Basal chitinous ring of genital armature; f, Ejaculatory duct; g, Thin membrane; h, Outer valve of genital armature; i, Bilobed portion of the same; j, Movable flap; k, Inner valves which serve as a penis.

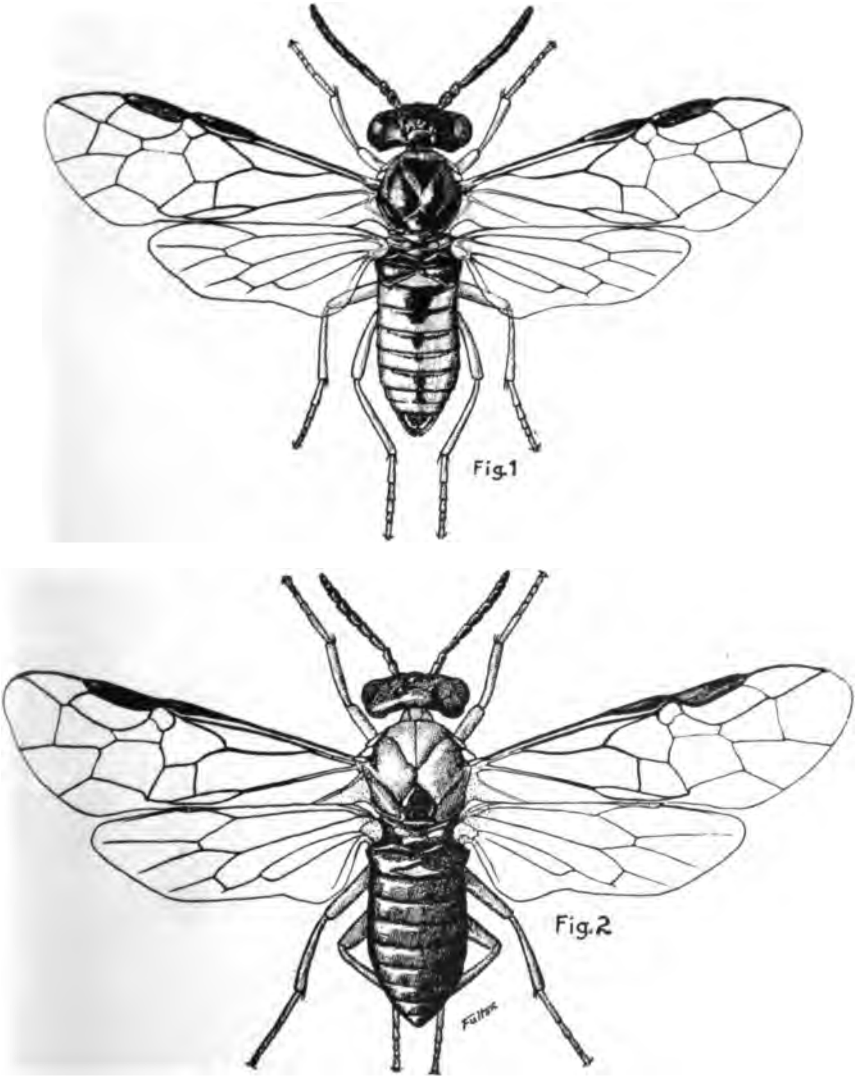

PLATE XXIV.— THE CHERRY AND HAWTHORN SAWFLY.
1, Male; 2, female.
(Enlarged 12½ times.)

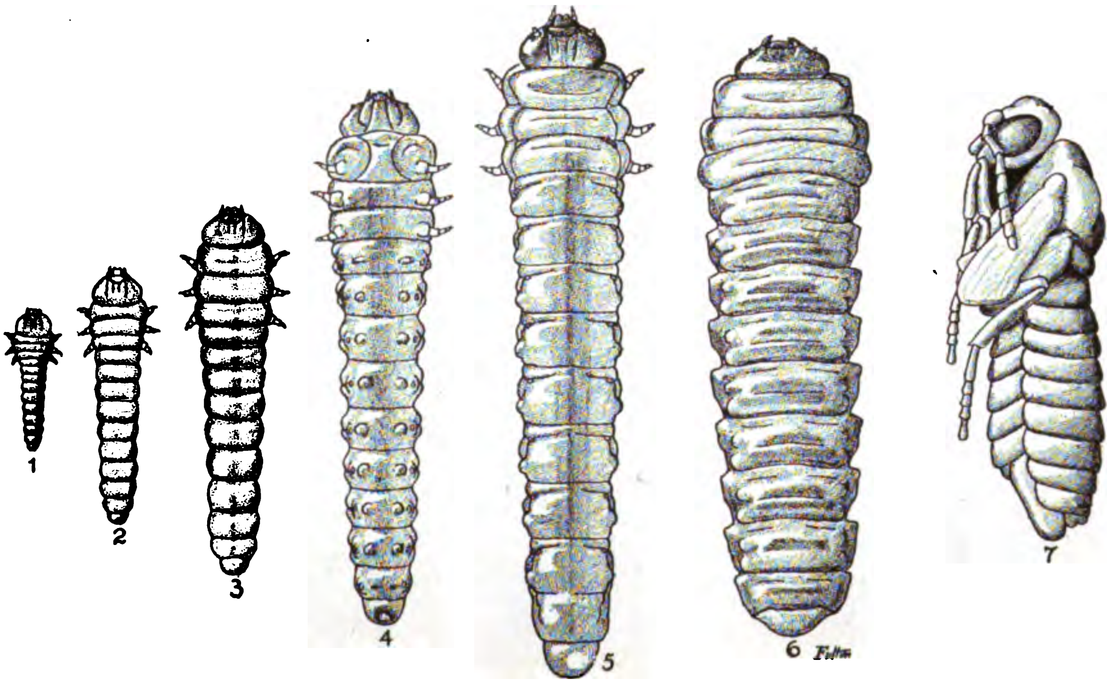

PLATE XXV.—LARVAL STAGES AND PUPA OF SAWFLY LEAF-MINER.

(Enlarged 12½ times.)

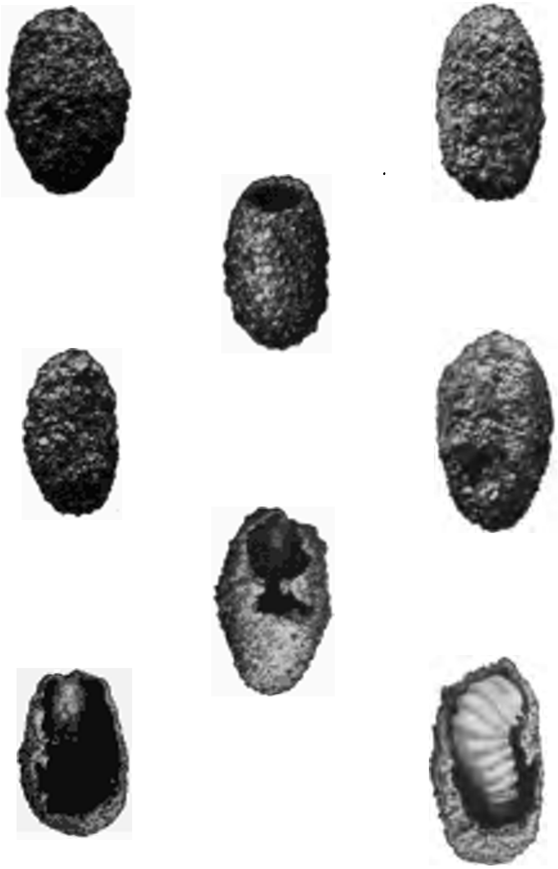

PLATE XXVI.—COCOONS OF THE CHERRY AND HAWTHORN SAWFLY LEAF-MINER.
(Enlarged.)

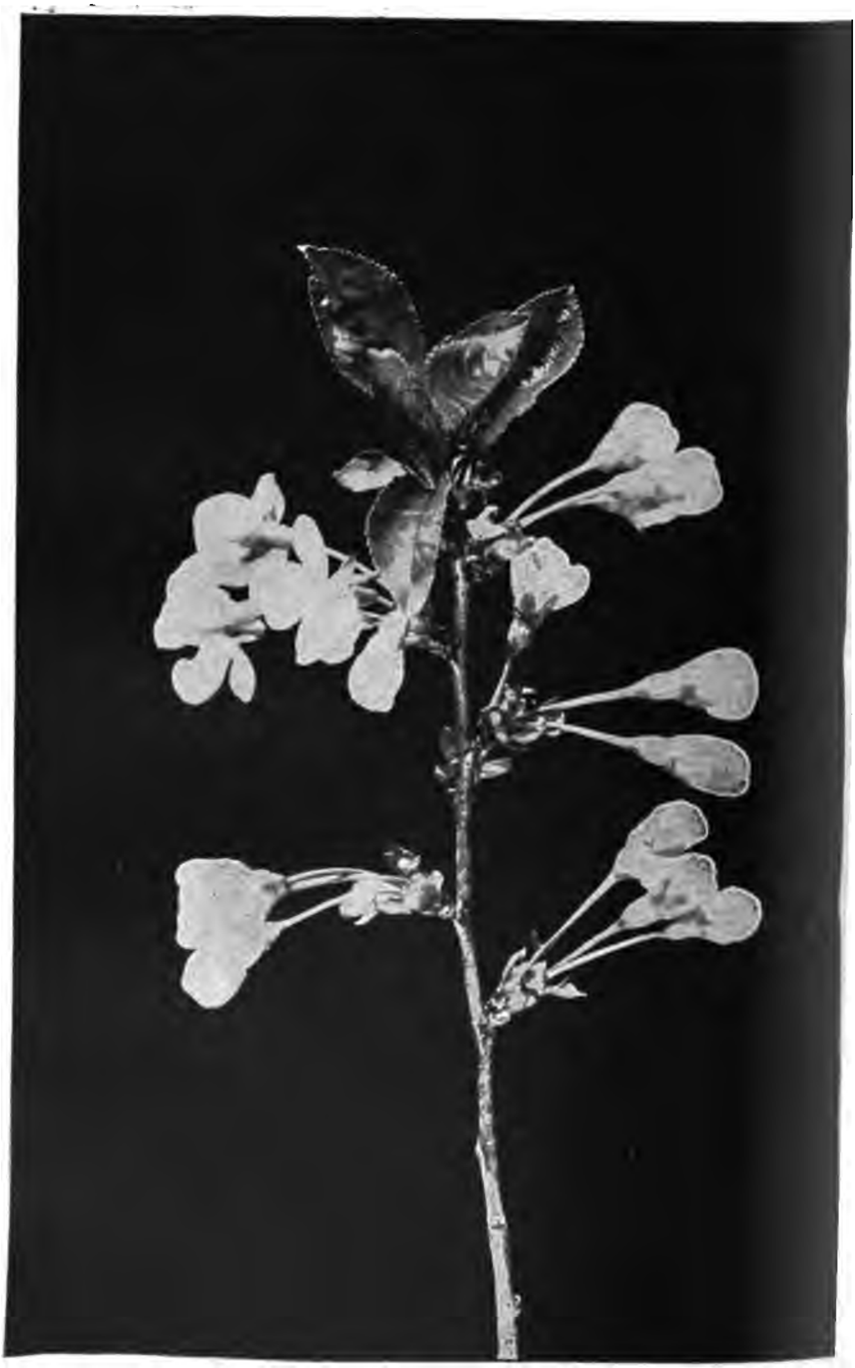

PLATE XXVII.—CONDITION OF CHERRY LEAVES AND BLOSSOMS AT PERIOD OF MAXIMUM OVIPOSITION.

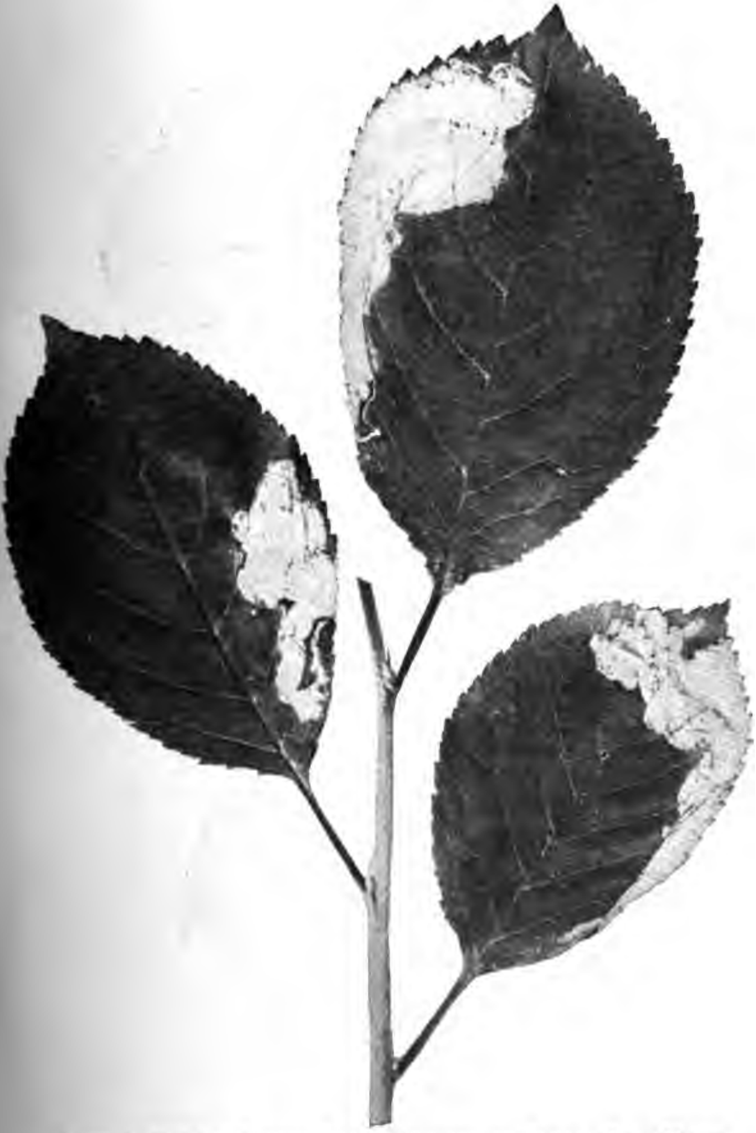

PLATE XXVIII.— CHERRY LEAVES INJURED BY SAWFLY LEAF-MINER.

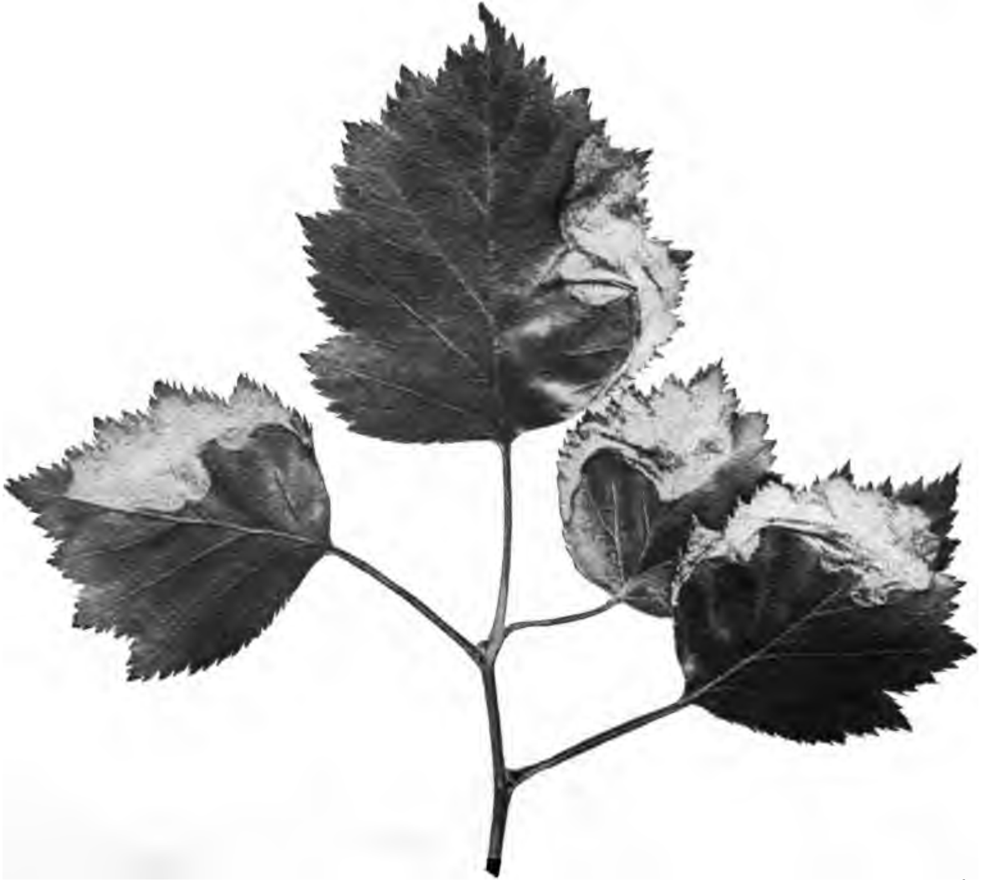

PLATE XXIX.— HAWTHORN LEAVES INJURED BY SAWFLY LEAF-MINER.

others originate on the ventral part of the base of the outer valve; the innermost of these is attached near the middle of the rod and pulls the outer end downward and inward (Fig. 14, g); the other is attached to the inner end and serves to raise the outer end (Fig. 14, h). The remaining one which originates on the ventral and lateral part of the outer valve and is attached near the middle of the rod pulls the outer end downward and outward (Fig. 14, e).

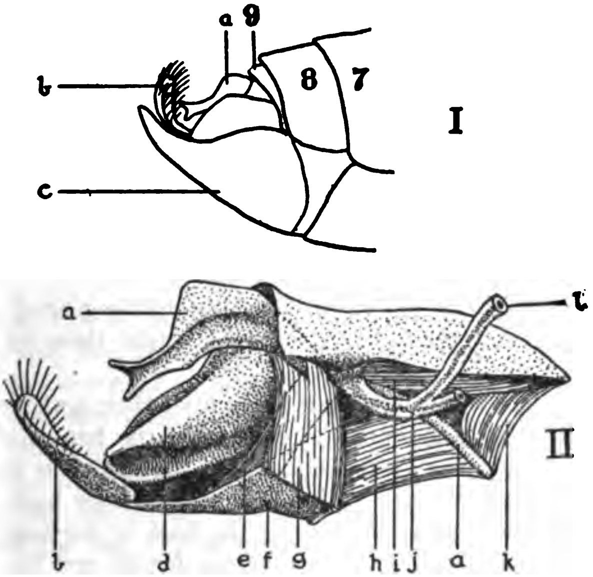

FIG. 14.— MALE GENITAL ARMATURE.

I, Tip of abdomen showing position of armature; II, Median section showing left half of armature, 7, 8 and 9, corresponding abdominal segments; a, Inner valve; b, Movable flap; c, Subgenital plate or sternum of ninth abdominal segment; d, Bilobed piece; f, Outer valve; e, g, h, i, and k, Muscles attached to the base of the inner valve; j, Ejaculatory duct; l, Vas deferens.

LIFE HISTORY AND HABITS.

EMERGENCE OF ADULTS.

From puparia obtained on April 18, 1913, by sifting earth from beneath cherry trees, two males and seven females made their appearance during a period extending from April 28 to May 2. On May 6 six males and six females were obtained in a cherry orchard, and only one of the sawflies was obtained in cages intended to trap the creatures as they emerged from the ground. On May 7 five males and seven females were caught in breeding cages, and at this date the insects were present in large numbers on the trees. The insects continued to appear in the cages, a few each day, until May 19, which was the latest date for the emergence of the sawflies for that year. During 1915 adults were observed on cherry trees during the first and second weeks in May and none of the insects were observed after the fifteenth day of this month. Observations for several seasons show that the flies make their appearance when the first leaf clusters are unfolding and the cluster buds are beginning to open (Plate XXVII).

EARLY HABITS OF THE SAWFLIES.

At the time of their emergence from the ground the sawflies are fully colored and are very active creatures. They are apparently very susceptible to temperature conditions. If disturbed on cold days they drop suddenly from the foliage, attempting to fly while in mid-air. Failing in this effort, they drop to the ground and crawl to some elevated object, on which they renew their attempts to seek flight.

They copulate within less than a day after their appearance from the soil. In this act, the male approaches the female backwards so that the tips of the abdomens come in contact while their heads face in opposite directions. Then the male reaches back with the hind legs and grasps the female over the back of her body, placing the tip of his abdomen under that of the female and inserting the penis under the flap at the base of the ovipositor. The outer flaps of the male genitalia are pressed closely against the underside of the female's body. The whole process is a matter of one to three minutes. One pair contained in an observation jar copulated three times within a space of half an hour.

OVIPOSITION.

The females are apparently ready to oviposit soon after they make their escape from the ground. One specimen was dissected about seventeen hours after its appearance, and in the ovaries and oviducts there were counted fifteen fully developed eggs. Another that had been out for two days began to deposit eggs immediately when cherry leaves were introduced into its cage. In the orchard eggs were first found during the year 1913 on May 7 in which season adults were first observed on May 6, although the insects may have been present on the trees for a day or two before and escaped detection. In 1915 all of the eggs were deposited by May 15. During the first days of the oviposition period one or sometimes two leaves in a cluster may show the presence of eggs. The females seem to manifest a preference for the leaves that first appear and which are still in an unfolded state. (Plate XXVII.) The process of oviposition requires only about one minute, but details of this operation proved difficult to determine and were not ascertained because of the extreme shyness of the females, which fly quickly on the approach of any object.

The lower surface of the egg lies in contact with the lower epidermis, which has been cut free from the other tissues of the leaf so as to form a small blister-like cavity or pocket. The egg is usually within one or two millimeters from the edge of the leaf; rarely on the extreme edge or more than three millimeters from the margin. On the upper side at the edge of the cavity there is usually a stoma through which the ovipositor is probably thrust. An examination of ninety-one eggs at random shows that they are more often deposited near the base of the leaf than the tip. About seventy per ct. of the eggs were in the area of the leaf from one-eighth to one-third the distance from the base; twenty per ct. near the middle and about ten per ct. of the eggs occurred in the portion of the leaf toward the tip. From one to five eggs were observed on a single leaf and the average for all observations was two and three-tenths eggs per leaf.

PARTHENOGENESIS.

Parthenogenesis frequently occurs among sawflies. According to Cameron[4] complete parthenogenesis may be observed " with such European species as *Eriocampa ovata*, *Pœcilosoma pulveratum* and *Crœsus varus* while the mixed parthenogenesis of *Nematus ribesii* and *N. miliaris* is beyond dispute." He further says that " from the readiness with which so many species deposit ova without having any connection with the males, and from the general scarcity of the latter, it seems evident that further investigation will show that the phenomenon is of very common occurrence." It is also to be noted that reproduction of this nature may also extend beyond one generation. With the species[5] *A. fasciata* a third generation was produced without any male connection.

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[4] Cameron, Peter, Mon. Brit. Hymenoptera, 1:28, 1882.

Webster[6] has recently suggested that parthenogenesis probably occurs with the pear slug (*Caliroa cerasi*), a destructive and widely distributed species in this country, although this has not been satisfactorily proven. In his studies he collected and examined large numbers of the adults, without finding a male, and in breeding experiments virgin females deposited eggs, some of which hatched, the larvæ unfortunately living only a few days. He makes the statement also that no specimens of the male exist in the collection of this species in the United States National Museum. Nevertheless Harris and several European writers have in their discussions of the species mentioned the occurrence of a male.

In view of the foregoing accounts *Profenusa collaris* was observed carefully with respect to the relations of the sexes to each other. Out of doors the females appeared in larger numbers at a somewhat earlier period than the males, but judging from collections taken at irregular intervals it does not appear that marked numerical differences existed between the sexes. To all appearances the adults copulated freely. In one breeding cage, containing no males, two females made their appearance, and these were isolated and supplied with cherry twigs to induce oviposition. This they did and five days later three eggs hatched. This experience suggests that fertilization is not absolutely necessary for the development of the eggs and also indicates that parthenogenesis may occur, although it is perhaps not an important factor in the life of the species.

HATCHING AND LARVAL ACTIVITIES.

During 1913 young larvæ were first observed on May 24 as trees were coming into full bloom, but, judging from the sizes of some of the mines it was evident that a few eggs had hatched one or two days earlier. By May 27 the hatching period was practically completed. During 1915, a few eggs were hatching on May 15. In the field it proved difficult to determine the period of incubation, but eggs deposited on cherry in the insectary hatched in five to eight days from date of oviposition. Under normal conditions incubation would probably extend over a larger number of days.

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[5] Cited by F. V. Theobald in Insect Pests of Fruit, p. 276, 1909.

[6] Webster, R. L., Iowa Agr. Exp. Sta., Bul. 130, 1912.

Upon hatching the young larva works its way through the tissue of the leaf until it reaches the upper epidermis. It usually mines towards the distal end of the leaf, generally keeping close to the edge and feeding with the ventral side in contact with the upper epidermis. When the tip of the leaf has been reached the creature reverses its course, proceeding along the area adjoining the midrib, or if there is no interference by another larva it may cross over the mainrib and tunnel back along the edge of the opposite half of the leaf.

The mine, as viewed from above, during its first stages of development is rather dark brown in color, which is accounted for in part by frass along the edges of the roof of the tunnel. As the affected area increases in size, especially in its breadth, the mine becomes light brown, while the edges incline to a darker shade. Observed from beneath the only visible indication of the initial activities of the insect is a small oval spot which marks the original cavity constructed by the adult for the reception of the egg, and this contains in addition to the shriveled egg membrane accumulations of frass from the early feeding operations of the larva. Later the under side of the tunnel also becomes brown, with the exposed epidermis wrinkled, but in general the destructive work of the insect is not so apparent on the lower as on the upper surface of the leaf.

There is a fairly definite relationship between the size of the mine and the age of the larva with respect to the different instars. In general mines under 5 millimeters long and 2 millimeters at their greatest width contain larvæ in the first instar; mines that are 5 by 2 millimeters to 12 by 4 millimeters contain larvæ in the second instar; mines that are 8 by 5 millimeters to 18 by 6 millimeters contain larvæ of the third instar; mines that are 18 by 6 millimeters to 28 by 8 millimeters contain larvæ of the fourth instar, and mines of greater dimensions than the foregoing are occupied by larvæ of the fifth instar.

PUPATION.

Upon reaching maturity the larvæ make a hole in the tissues forming the mine, usually the upper epidermis, which forms the roof. From the opening they make their escape to the edge of the leaf, when they drop to the ground. During 1912 the larvæ began to leave the foliage on June 7, and by June 10 it was estimated that fifty per ct. of the insects had abandoned their mines. On June 18 it was difficult to find a specimen on the tree, while June 22 was the latest date that any of the insects were seen on the leaves. During 1915 small numbers of larvæ began to drop from the leaves to the ground on June 5, and by June 16 the foliage of cherries was practically free of the insects. Upon reaching the ground the creatures bury themselves several inches deep in the soil and construct an earthen cell. The cocoon, which is oval in shape, consists of particles of earth glued together and lined with a cement which renders it impervious to water and strong enough to resist considerable pressure without crushing. (Plate XXVI.) The insect passes the winter in the larval stage. However, the pupa begins to form in the fall. Specimens obtained during October showed the developing compound eyes and ocelli, while of examples secured the following April the adult characters of the head could be plainly seen through the skin, and their bodies were decidedly humped. One of these specimens which was kept in a cool room transformed to a pupa on or before April 23 of the following spring. Others obtained from an orchard on May 2, 1913, were all in the pupal stage, and one female pupa was partly colored.

NATURAL ENEMIES.[7]

An efficient enemy of *P. collaris* is the chalcidid *Trichogramma minutum* Riley (Fig. 15), which is an egg parasite. According to Girault[8] this species leads as the most prominent and widespread parasite of the eggs of insects, having been recorded from thirty or more hosts in North America alone. It is stated that with one or two exceptions its hosts are all insects of the first economic importance, as the codling moth, brown-tail moth, etc., and that it confines its activities to the Lepidoptera and Hymenoptera. Besides the leaf-miner, the subject of this account, this parasite attacks other species of sawflies, as the peach and plum-leaf sawfly (*Caliroa amygdalina*)[9] and the pear slug (*Caliroa cerasi*). Webster [10] in his account of the latter states "that the pest is rarely destructive for many years at a time. It may be abundant for a year or so, then drop out of sight for several years." This alternating abundance and scarcity of the insect he attributes largely to the activities of its natural enemies, and in Iowa for several years during the course of his studies there were two species of egg parasites, of which *T. minutum* was the more common. One instance is noted when there was apparently a total parasitism of the eggs of its host.

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[7] Through the courtesy of Dr. L. O. Howard the identifications of the parasites were made by Messrs. A. A. Girault and S. A. Rohwer of the U. S. Bureau of Entomology.

[8] Girault, A. A. *Psyche* 18:146. 1911.

[9] Morgan, H. A., La. Bul. 48 Second Series, p. 144, and Cushman, R. A., U. S. Bureau of Entomology, Bul. No. 97, pt. V., p. 100.

[10] Webster, R. L., Iowa Bul. 130:187. 1912.

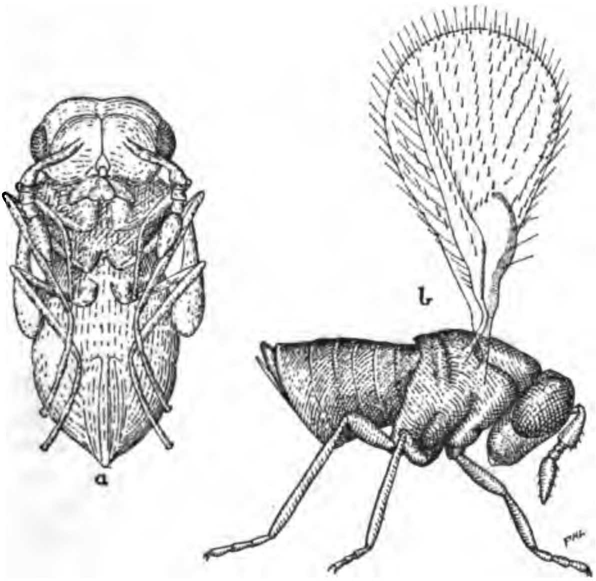

FIG. 15.— EGG PARASITE (*T. minutum*) OF THE SAWFLY. a, Pupa; b, Adult (enlarged).

During the past five years that *P. collaris* has been under observation by this Station, *T. minutum* has twice made its appearance in conspicuous numbers in cherry orchards infested with the sawfly, in 1912 and in 1915. During the former year the larger percentage of the eggs of the sawfly were parasitized and on some trees it was difficult to find an egg-bearing leaf which had not been visited by the parasite. In 1915, parasitism ranged from about forty to ninety per ct., on different trees. Taking all trees into consideration of the eggs deposited by the sawfly more than half failed to hatch, and for this mortality *T. minutum* appeared to be largely responsible.

The parasite was reared from both cherry and hawthorn foliage. The majority of the eggs of the sawfly that were dissected contained a single parasite, and in only a few instances were twin larvæ or pupæ observed. On June 2, 1915, the parasites were all in the larval state, but on June 5 when the larvæ of *collaris* were beginning to abandon their mines in the foliage about fifty per ct. of the parasites were in the pupal state. By June 7 they had nearly all transformed to pupæ, and on June 9 the first adult appeared. During succeeding days the chalcidids appeared in large numbers, and the last specimen to make its appearance emerged on June 14. While the parasite was abundant about Geneva during this year it was relatively quite scarce in plantings of *Cratægus* at Rochester.

Besides the foregoing parasite there has been reared from *P. collaris* an ichneumon which proved to be a new species and has been listed as *Pezoporus tenthredinarum* Rohwer. During 1913 quite a few pupæ were observed to be parasitized, presumably by this species, and in one collection of eleven cocoons of the sawfly, six specimens were parasitized. During this year adults of this parasite made their appearance in breeding cages from May 2 to 21, and some individuals were collected from cherry trees on May 29.

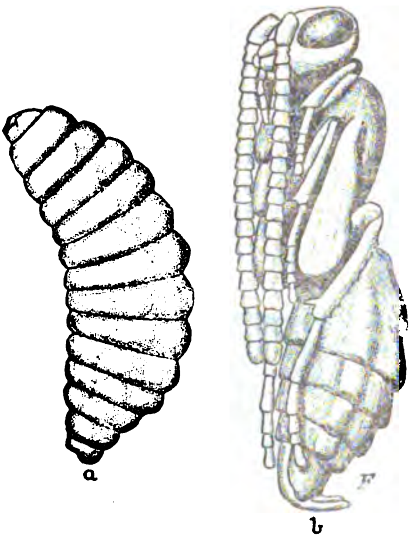

FIG. 16.— PARASITE (*Pezoporus tenthredinarum* ROHWER) OF THE SAWFLY.
a, Larva (× 12½); b, Pupa (× 18).

The larva (Fig. 16, a) is a whitish, spindle-shaped grub and is 4 to 5 millimeters long. The body is composed of thirteen segments and the head is small and inconspicuous. The entire skin is thickly covered with minute teeth. The pupa (Fig. 16, b) is whitish with dark eyes and shows all the characters of the adult. The wing pads are narrow and lie between the folded femora and tibiæ of the last two pairs of legs. The antennæ are extended along the ventral side, reaching about the fourth abdominal segment. The ovipositor curves dorsally around the last abdominal segment. The original description[11] of the adult is as follows:

"*Female.* (Fig. 17).— Length 6 mm. Anterior margin of the clypeus truncate with a narrow depressed edge; head below the antennæ opaque, granular with a few poorly defined punctures interspread; above the antennæ, shining, finely granular, almost impunctate; postocellar line subequal with the ocellocular line; posterior orbits as broad as the cephalocaudad diameter of the eye; flagellum stout, larger apically, the first joint slightly shorter than the second and a little more than twice as long as its apical width; second joint 2½ times as long as its apical width, the third, fourth and fifth joints subequal and 1½ times as long as their apical width; malar furrow well defined and limiting the granular, opaque sculpture of the face, separating it from the shining sculpture of the posterior orbits; mandibles with the teeth of equal length; mesoscutum shining, practically impunctate; suture between the scutum and scutellum broad, shallow, bottom finely foveolate; scutellum shining, practically impunctate; propodeum opaque; the longitudinal carinæ defining the basal area and the areola well defined; basal area and areola confluent; basal median lateral areas separated by a poorly defined carina which becomes subobsolete laterally; first tergite smooth, without strong sculpture, the lateral carinæ extending from base to apex; second and following tergites smooth, practically impunctate; areolet hexagonal with the basal and apical ends subequal, black; mandibles except the piceous apices, clypeus, antennæ (becoming infuscated and darker apically), and tegulæ white or whitish; legs rufo-ferruginous; first three tergites rufo-ferruginous, but the sides of the first and small lateral spots on the second and third, infuscate.

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[11] Rohwer, S. A. *Proc. U. S. Nat. Museum*, 49: 216. 1915.

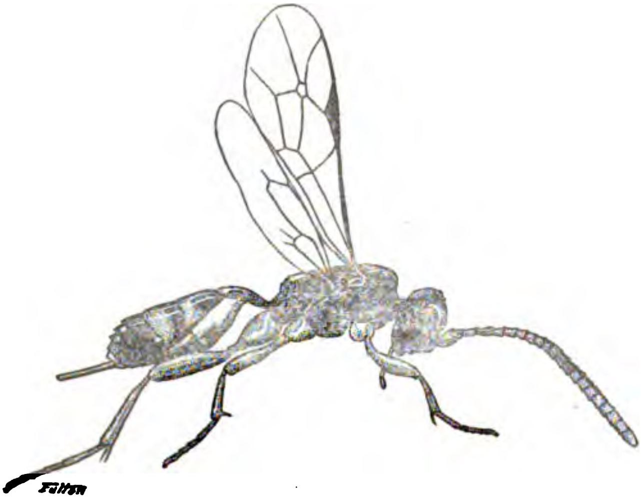

FIG. 17.— ADULT FEMALE PARASITE (*Pezoporus tenthredinarum* ROHWER) (× 12½).

Male.— Length 4.5 mm. Sculpture agrees well with the female; the antennæ are slightly longer and not so robust apically, the third joint is distinctly longer than the fourth; fourth and fifth are subequal, the sixth is slightly shorter than the fifth. Agrees with the female in color except the bases of the posterior coxæ are black and the tergites are black except the small ferruginous spot on the apex of the first, transverse apical bands on the second and third."

Apparently there is associated with the foregoing ichneumon an undescribed Tryphonine, but owing to the small numbers collected it is impossible to make any statement at this time as to its status as a parasite of the sawfly.

STATION EXPERIMENTS TO CONTROL THE SAWFLY ON CHERRY.

TESTS AGAINST NEWLY-HATCHED LARVAE.

By reason of the habits of the larvæ in burrowing into the interior of the leaves, insects such as the cherry sawfly are regarded as very difficult species to combat. The chief difficulty is that most spraying mixtures, when applied to foliage, fail to exert their toxic properties against the creatures, which is accounted for by the resistance of the leaf structures to penetration by the insecticides. An exception among this class of pests is the elm sawfly[12] (*Kaliosyphinga ulmi* Sund.), an insect with habits quite similar to the cherry species and which in recent years has been shown to be quite sensitive during the early stages of attack to nicotine solutions. The successful results in this case pointed to the desirability of tests on the spraying of cherry orchards with the same preparation in an effort to destroy the mining larvæ at the first appearance of initial injuries. To this end an orchard of English Morello belonging to Mr. Chas. K. Scoon of Geneva was placed at the disposal of the Station for two years, and each season the trees were sprayed with nicotine solution (40 per ct.) in the proportions of either one or two pints to one hundred gallons of water to which were added five pounds of soap. In spite of very thorough treatments and liberal applications of spraying mixtures there was no evidence at the conclusion of the operations of penetration of the mined areas of the leaves by the liquid or of any influence of the nicotine spray upon the larvæ. Later observations of the trees confirmed earlier impressions, for none of the treated trees showed any appreciable benefit from the different applications. Because of these results further attempts to combat the pest by this means were abandoned.

TESTS AGAINST MATURE LARVAE.

As previously described, the larva in its older instars consumes the mesophyl or pulpy substance of the leaf, leaving only a thin papery epidermis to protect the creature within its mine. The undermined epidermis forming the tunneled area or blister shows a shriveled or wrinkled appearance during dry weather, which would suggest that it might absorb spraying mixtures and prove penetrable to them to the disadvantage of the enclosed insect. The following tests were designed to determine the effectiveness of various insecticides upon the insect under such conditions.

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[12] Herrick, Glenn W. Cornell Univ. Agrl. Expt. Sta. Bul. 333, 1913.

On May 28 several lots of branches each showing several larvæ were noted. Applications of various insecticides were then made and three days later the different lots of branches were examined to determine the effects of the treatments upon the larvæ. The results are summarized in Table I.

TABLE I.—EFFECTS OF INSECTICIDES ON LARVAE OF CHERRY SAWFLY LEAF-MINER.

No. of twig	TREATMENT.	EFFECTS ON LARVÆ.	
		No. dead.	No. alive.
1	Concentrated solution of naphthalene in alcohol	....	5
2	Concentrated solution of naphthalene in alcohol	1	5
3	Kerosene emulsion, 1 to 15	6	32
4	Kerosene emulsion (1–15), 45 parts; naphthalene in alcohol, 5 parts	....	25
5	Kerosene emulsion, 1–10	1	47
6	Kerosene emulsion (1–10), 45 parts; naphthalene in alcohol, 5 parts	5	21
7	Commercial miscible oil, 1–50	....	16
8	Miscible oil (1–50), 45 parts; naphthalene in alcohol, 5 parts	5	21
9	Miscible oil (1–50), 40 parts; naphthalene in alcohol, 10 parts	1	21
10	Nicotine solution, 40 per ct., 1–800	....	17
11	Nicotine solution, 40 per ct., 1–800	1	7
12	Nicotine solution, 40 per ct., 1–800	1	18
13	Nicotine solution, 40 per ct. (1–800), 15 parts; oil emulsion, 1 part	2	16
14	Nicotine solution, 40 per ct. (1–800), 15 parts; oil emulsion, 1 part	1	23
15	Nicotine solution, 40 per ct. (1–800), 10 parts; oil emulsion, 1 part	4	41

The great resistance displayed by the larvæ to the foregoing insecticides prompted some tests with undiluted kerosene and gasoline, applied to trees by spraying machine or to the mines of the insect directly by means of a paint brush. The results were somewhat marred by the fact that some of the larvæ were beginning to leave the foliage; but the difficulty of killing any appreciable number of the insects by even these substances is indicated by the accompanying counts, which were made twenty-four hours after the applications.

TABLE II.— EFFECTS OF OILS ON LARVAE OF CHERRY SAWFLY LEAF-MINER.

No. of twig	TREATMENT.	CONDITIONS OF MINES WITH RESPECT TO LARVÆ.		
		No. dead.	No. alive.	No. missing
1	Kerosene as a spray	2	7	6
2	Kerosene as a spray	1	13	9
3	Kerosene applied with a brush	....	6	3
4	Gasoline as a spray	....	4	4
5	Gasoline applied with a brush	1	8	3

The results of the foregoing tests require no extended comments. The experiments point consistently in one direction, showing that the larvæ of *Profenusa collaris* when under normal conditions in the foliage are not susceptible to ordinary spraying practices, as the more common insecticides do not penetrate the epidermal tissues of the cherry leaf.

TEST WITH HYDROCYANIC ACID GAS AGAINST LARVAE.

For comparison with various spraying mixtures one tree was fumigated with hydrocyanic acid as the eggs were hatching and the mines of the young larvæ were first beginning to show. Potassium cyanide was used at the rate of 0.20 gram per cubic foot and twenty minutes was allowed for the period of fumigation. Of the various treatments given cherry trees to combat the larvæ this was the only one that proved efficient. There was a total destruction of the insects and, in marked contrast to adjacent trees, the foliage of the fumigated tree was absolutely free from mines or blisters so characteristic of the work of the pest.

REMOVAL OF AFFECTED LEAVES.

It is to be noted that of the foregoing tests fumigation with hydrocyanic acid gas was the only treatment that efficiently checked the destructive activities of the mining larvæ. Effective as is fumigation, it appears from our experience with the pest that this is an impracticable means of protecting cherry orchards, as the losses due to the work of the insect would hardly warrant the expenditure for necessary equipment. There remains only for consideration the removal of affected leaves as the most economical and really satisfactory method of combating the sawfly. The chief merit of this operation is that an almost complete destruction of the larvæ may be effected, but this involves the removal of all the tunneled leaves. The loss of foliage may seem large, but it is more apparent than real since many of the leaves are liable to be so severely injured as to be of little service to the tree; and moreover with careful work, accompanied by destruction of uncultivated host plants, smaller numbers of the leaves should need to be removed with each succeeding year. In a test to determine the labor involved there was required approximately one and one-half hours per tree for a man to remove all affected leaves, ranging from a thousand to twelve hundred in number, from trees that averaged about thirteen feet high and of about the same breadth. Compared with the cost of spraying for certain fruit pests the expense, on the basis of these figures, is not large and could doubtless be greatly reduced by the employment of children or other cheap help.

TEST WITH SWEETENED BAIT TO POISON ADULTS.

At the time of appearance of sawflies in maximum numbers on the trees, applications of a sweetened arsenical spray, composed of arsenate of soda and sugar, were made on May 20, 1913, to the foliage for the purpose of poisoning the insects. The ground beneath a number of trees was covered with cheesecloth screening for the purpose of catching such flies as should happen to drop from the leaves as a result of feeding on the poisoned bait. A few sawflies did actually feed on the sprayed leaves and one of the specimens died in about one hour, but the majority of the insects were not attracted to the mixture. Observations of the sprayed plat for several days failed to detect any of the creatures on the screens spread beneath the trees.

The foregoing experiment was repeated on May 18, 1914, on four rows of Morello cherries, averaging about fifteen trees to a row. The following formula was used:— arsenate of lead 4 ounces, corn syrup 2 pounds, and water 4 gallons. The spray was applied in quantities sufficient to wet the foliage of individual branches, and applications were made to different portions of a tree. The cherries were in full bloom, at which time the flies were numerous and very active. There was no evidence of feeding on the poisoned bait by any appreciable numbers of the insects. Oviposition on succeeding days was quite extensive, and as was the experience during the previous year the application of the arsenical afforded no apparent protection to the trees.

TESTS WITH NICOTINE SOLUTION TO DESTROY ADULTS.

As the sawflies are sluggish during cold mornings and if disturbed attempt to drop rather than fly, two experiments were made in successive years to destroy them when temperatures were low by applying nicotine solution, 40 per ct., three-fourths pint to one hundred gallons of water and five pounds of soap. In each case the treatments were ineffectual as only a few of the flies were apparently affected by the application.

TEST OF SPRAYING TO PREVENT OVIPOSITION.

In an effort to prevent oviposition or reduce the extent of egg-laying, ten rows of Morellos with fifteen trees to a row were sprayed as leaves were unfolding as follows:

Two rows with bordeaux mixture (6–6–50) and lead arsenate 3 pounds.

Three rows with nicotine solution, 40 per ct., three-fourths pint to 50 gallons of water and 3 pounds of soap.

Two rows with lime-sulphur, 1–50.

One row with whitewash, 25 pounds lime to 50 gallons of water.

In spite of thorough spraying of the unfolding leaves the trees receiving applications of the above mixtures showed no appreciable benefits as a result of the different treatments.

CONTROL OF THE LEAF-MINER ON HAWTHORNS.

Contrary to the results of our spraying experiments in cherry orchards (see page 426), the leaf-miner when on hawthorns appears to be susceptible to spraying with nicotine solution and soap. Dr. C. S. Sargent[13] of the Arnold Arboretum states that in order to protect the hawthorn plantings, it has become necessary to spray them each year, and that the most effective treatment is the foregoing mixture, which should be applied as soon as the larvæ begin to tunnel the leaves.

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[13] Letter of June 11, 1915.

This spring, under the direction of Mr. John Dunbar, Assistant Superintendent of Parks, Rochester, a test was made of this same mixture on a goodly number of hawthorns of the variety *C. Geneseensis*. In one plat an application was made on May 8, at which time the eggs of the species were being deposited, while in a second plat treatment was given on May 24 when the larvæ were hatching. The earlier spraying was quite ineffective, but the later application resulted in a noticeable reduction in the number of affected leaves. While the plants were not entirely free from affected foliage, they presented much better conditions than the checks and the plat that received the early treatment.

METHODS OF CONTROL.

REMOVAL OF AFFECTED LEAVES.

Of the operations, systematically practised, one that will probably prove most effective and economical in controlling the leaf-miner is the picking of affected leaves. This species is peculiarly susceptible to this kind of repressive method since there is only one brood of larvæ to attack the foliage and oviposition extends over only a short period. The effect is that hatching of eggs and maturing of larvæ are, practically speaking, almost simultaneous for all of the creatures, and their activities during their injurious stages are restricted to a relatively short period. By careful timing it is possible at a single picking to collect practically all of the larvæ by removing the affected leaves, which should then be burned to destroy the insects. The removal and destruction of all mined leaves, coupled with another practice — the destruction of wild hawthorns in the immediate vicinity of the cherry orchard — should leave few opportunities for the pest to develop to injurious numbers.

FUMIGATION WITH HYDROCYANIC ACID GAS.

Of the various measures employing insecticides tested by this Station to protect cherry foliage from the work of the leaf-miner, only fumigation with hydrocyanic acid gas was effective. Most cherry growers in New York are not equipped with suitable apparatus to undertake this means of affording protection to their trees, and fumigation should only be undertaken as an extreme measure and in an experimental way under expert direction.

CULTIVATION.

Cultivation, if done with care and at the proper time, is destructive to many insects with subterranean habits. Species especially that undergo pupal development in the ground are not only peculiarly sensitive to disturbances of the soil, but ploughing and cultivation, besides breaking up the cells of hibernating larvæ, exerts another detrimental influence, exposing the helpless insects to insectivorous birds and other foes. Since it is the normal habit of the larvæ of this sawfly to live in earthen cells for the greater portion of the life cycle of the species, such practices as fall or early spring ploughing or cultivation are to be recommended from an entomological standpoint. These measures, fortunately, are standard operations which are invariably practiced by the more successful cherry growers.

DESTRUCTION OF UNCULTIVATED HOST-PLANTS.

The fact that the sawfly is very partial to hawthorns, especially of the *Crus-Galli* group, and breeds most abundantly on them, suggests the desirability of destroying these plants when they exist in the immediate vicinity of an orchard of the English Morello cherry. The value of this operation is not known; but until there is more knowledge of the breeding habits of the pest the removal of wild plants along roadsides and hedge rows that are attractive to the insect for purposes of propagation would appear advisable as a precautionary measure.

SPRAYING OF HAWTHORNS.

For the protection of hawthorns in decorative plantings, spraying seems to be preferred to any of the preceding measures. The insecticide which has given the most satisfactory results is composed of one pint of nicotine solution (40 per ct.) to one hundred gallons of water to which are added four pounds of soap. In making the treatment the liquid should be used in liberal amounts and applied with rather high pressures at the time when the insects first begin to mine the foliage.

THE TREE CRICKETS OF NEW YORK: LIFE HISTORY AND BIONOMICS.*

BENTLEY B. FULTON.

SUMMARY

Most of the tree crickets found within the boundaries of New York State are generally distributed over the eastern United States, while some range as far as the Pacific Coast states. They include seven species of the genus ***Œcanthus*** and one species of the genus ***Neoxabea.***

The interest in these insects centers chiefly about their remarkable reproductive structures and instincts and their peculiar oviposition habits. The song of the male, which serves to attract the female, is produced by a minute rasp on the under side of the forewing which is scraped by a structure on the inner edge of the opposite wing. In producing the sound the wings are raised at right angles to the body and vibrated rapidly. When the wings are so raised, there is exposed on the metanotum a glandular hollow, the secretion of which is very attractive to the female. The latter climbs over the abdomen and feeds on the gland. The male takes advantage of the position and inserts the barbed capillary tube of a spermatophore into the genital opening of the female and the sperms pass into the seminal receptacle. The spermatophore is formed in a peculiar pouch at the tip of the abdomen, by the hardening of a viscous liquid about a mass of sperms.

The female prepares for oviposition by chewing a small pit in the bark of the plant. The drilling is accomplished by quick downward thrusts of the ovipositor and a slower twisting motion. After the egg is deposited a quantity of mucilaginous substance is discharged into the hole, and with most species the female plugs up the opening with chewed bark or excrement.

The species of ***Œcanthus*** can be divided into three natural groups according to their morphology, coloration and habits. The first group includes ***niveus, angustipennis***, and ***exclamationis.*** These are pale whitish crickets, very similar in appearance. All have an intermittent song and deposit their eggs singly in the bark of trees and bushes. The song of ***niveus*** consists of a series of clear, rhyth-

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* A reprint of Technical Bulletin No. 42, May, 1915.

mically repeated whistles with a pitch about C, two octaves above middle C. The number of notes varies from about sixty to over a hundred and fifty per minute according to the temperature. The songs of *angustipennis* and *exclamationis* are non-rhythmical and have longer notes and rests, generally not more than fifteen per minute.

The second group of species includes *quadripunctatus, nigricornis* and *pini*. The song of these crickets is a continuous, shrill, high-pitched whistle. All three species place their eggs in rows in the pith of small stalks or twigs. *Quadripunctatus* deposits its eggs in loose rows in small or medium sized weeds. The eggs of *nigricornis* are placed in compact rows in large weeds or in the twigs of trees and bushes. *Pini* oviposits only in pine twigs, so far as known.

The third type is represented by a single species, *latipennis*. The song of this cricket is a loud, clear whistle with a musical, ringing quality. The female oviposits in grape vines and weed stalks. A single hole in the outer woody layer of the stem serves for the deposition of from four to twelve eggs, which are placed side by side in the pith in two groups, one above and one below the opening.

***Neoxabea bipunctata* is closely related to crickets of the genus *Œcanthus* and was formerly classified with them. Although generally distributed over the eastern half of the United States, it does not extend very far north and is known to occur in this State only in the southeast corner. It has been collected from oak, willow and grape vines, and deposits its eggs singly in the bark or cambium.**

INTRODUCTION.

In our studies dealing with the economic aspects of tree crickets, we extended our observations to several species which do not affect cultivated crops, considering especially certain interesting habits which have little or no bearing on the horticultural importance of the insects as a group. These accumulated data have been brought together in this bulletin. The species discussed include only those which inhabit the eastern United States. Several other species of *Œcanthus* occur in the southwestern states, but living specimens of these could not be obtained and therefore they were not considered in this investigation.

It seemed advisable to include in the present work some material that has already been presented, at least briefly, in Bulletin No. 388, and a few parts, such as technical descriptions, have been copied literally.

All descriptions and measurements are taken from living or recently killed insects, which may differ considerably from dried and shriveled specimens.

GENERAL CHARACTERISTICS.

The term "tree cricket" is commonly applied to any of the tree- or bush-inhabiting insects of the family Gryllidæ. The commonest and best known of these, however, belong to the genus *Œcanthus*, of which there are about twenty-seven known species. According to Kirby (31)* sixteen of these are found on the American continent, while, of the remaining species, one occurs in Europe and the others inhabit various parts of Africa, Asia and the East Indies, with one extending as a rare species into Australia. All members of the sub-family *Œcanthinæ* known to exist in our fauna are included in this genus, except one species which has been placed in a separate genus, *Neoxabea*. These insects are among the most specialized of the Orthoptera and they are characterized by their slender shape, pale color and arboreal habits. From all other members of the Gryllidæ, the *Œcanthinæ* can be readily distinguished by the following characters: The tarsi are three-jointed, and the second segment is small and compressed. All the legs are very slender and in *Œcanthus* are armed with two rows of minute teeth interspersed with a number of delicate spines. The males have very broad and flat tegmina which lie in a horizontal position over the abdomen, while those of the female are narrow and wrapped closely about the body. The two basal segments of the long, filiform antennæ are generally ornamented with peculiar and distinctive black markings which are fairly constant and serve as convenient characters for separating the different species.

The various species of *Œcanthus* in this faunal region seem to fall naturally into three groups as indicated by their morphology, coloration and habits. These groups are typified by the species (1) *niveus*, (2) *nigricornis* and (3) *latipennis*. The first group includes those which live mostly among woody plants, either bushes or trees, and deposit their eggs singly in various places in the bark of the plants. The second group comprises those species which deposit their eggs not in the bark but in the inner pith cavity of small stalks or twigs, making a separate puncture for each egg and grouping them more or less closely in long rows. The third type is represented here by only one species, which places several eggs in the central pith through the same opening in the outer woody layer of the stem, arranging them in two groups, one above and one below the opening. The structural and color characters separating the three groups are indicated in the following key to the species that occur in this region.

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*Numbers in () refer to Bibliography, pp. 476 and 477.

KEY TO THE SPECIES OF *Œcanthus* FOUND IN EASTERN NORTH AMERICA.

A Basal segment of antennæ with a swelling on the front and inner side. First and second segments each with a single black mark.

B Basal antennal segment with a round black spot. (Fig. 18, a) *niveus* De Geer

BB Basal antennal segment with a J-shaped black mark. (Fig. 18, b) *angustipennis* Fitch

BBB Basal antennal segment with a straight club-shaped black mark. (Fig. 18, c) *exclamationis* Davis

AA Basal antennal segment without a swelling on the front and inner side. First and second antennal segments each with two black marks or entirely black. Tegmina of male 5 mm. or less in width.

B Head and thorax pale yellowish-green or black or marked with both colors.

C First antennal segment with a narrow black line along inner edge and a black spot near the distal end. Body entirely pale yellowish-green. (Fig. 18, d) *quadripunctatus* Beut.

CC First antennal segment with black markings similar to above, but broader and usually confluent, sometimes covering the whole segment. Head and thorax often with three longitudinal black stripes: ventral side of abdomen always solid black in life. (Fig 18, f, g) *nigricornis* Walker

BB Head, thorax and antennæ reddish brown. Wings in life with conspicuous green veins. Marks on basal antennal segment broad but seldom confluent. (Fig. 18, e) *pini* Beut.

AAA Basal antennal segment without a swelling on the front and inner side. Basal portion of antenna red, unmarked with black. Tegmina of male about 8 mm. wide. (Fig. 18, h) *latipennis* Riley

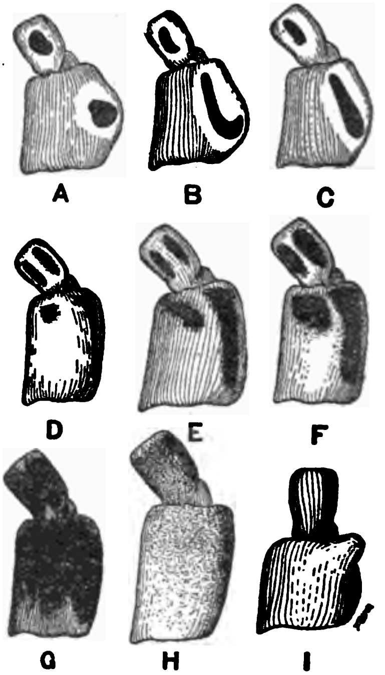

FIG. 18.— BASAL ANTENNAL SEGMENTS OF TREE CRICKETS.

a, *Œcanthus niveus*; b, *Œ. angustipennis*; c, *Œ. exclamationis* ; *d*, *Œ. quadripunctatus*; e, *Œ. pini*; f, *Œ. nigricornis*; light form; g, *Œ. nigricornis*, dark form; h, *Œ. latipennis*; i, *Neoxabea bibunctata*.

GENERAL DESCRIPTIONS OF LIFE STAGES OF ŒCANTHUS.

Egg.— The eggs of the species belonging to the genus *Œcanthus* are elongate, cylindrical and slightly curved. At the time of deposition they are semi-transparent, but later they grow more opaque and become slightly swollen. The cephalic end possesses a whitish opaque cap, which is covered with minute projections, arranged in spiral rows after the fashion of the scales of a pine cone. At the extreme base of the cap, only shallow rhombic depressions occur, but above the first few rows short projections appear between the indentations and gradually increase in size in each successive row. The entire surface of the egg, exclusive of the cap, is etched with what appear to be very minute cross-hatched scratches. The number and size of the spicules vary considerably with different species and are useful characters for distinguishing the eggs of certain of the crickets.

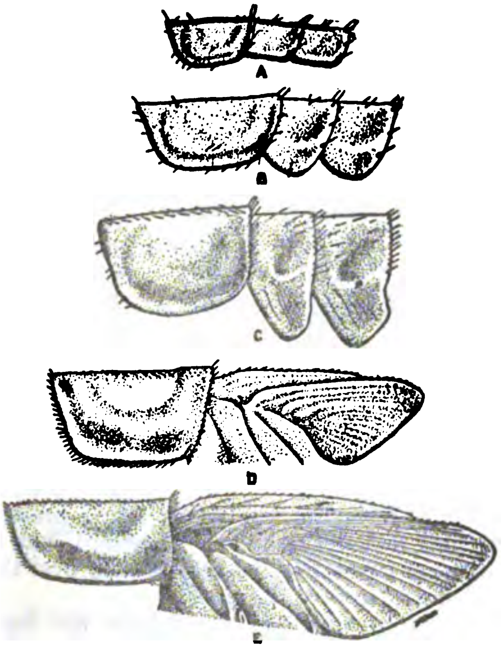

FIG. 19.—THORACIC SEGMENTS OF THE FIVE NYMPHAL INSTARS.

Nymph.— The newly hatched nymphs are very pale and delicate. After feeding, the size of the abdomen is increased and the contents of the alimentary canal show through the body wall and give the insect a darker color and more robust appearance. The appearance of the nymphs and the characters distinguishing the different instars are shown in Plate XXX and Fig. 19. The first instar is characterized by having only thirty-four segments in the antennæ while the sides of the meso- and metanotum do not project, and they extend downward scarcely as far as do the sides of the pronotum. The second instar differs from the first by a slight downward extension of the sides of the meso- and metanotum. The edges are free and lap over the pleura. The antennæ have about double the number of segments of the first stage. The third instar is characterized by a still further prolongation of the sides of the meso- and metanotum so that they appear as distinct and rudimentary wing pads. The antennal segments are increased to nearly one hundred. On the fourth instar the wing pads are folded back over the thorax and reach to the second abdominal segment. In the fifth instar they reach to the third or fourth segment.

The differences between the three groups of species are plainly evident in the first instar (Fig. 20). In the *niveus* type the nymphs are white with a few fine black marks on the head and thorax; in the *nigricornis* type they are pale greenish yellow with a slight dorsal infuscation and a pale median line; and the nymphs of *latipennis* are white with a purplish red dorsal area and a pale median line.

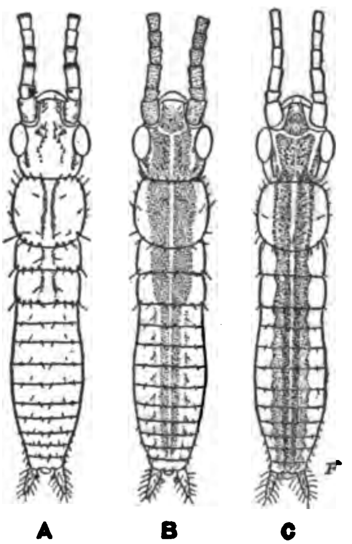

FIG. 20.— NYMPHS OF THE FIRST INSTAR, ILLUSTRATING THE THREE TYPES OF *Œcanthus*.
a, *niveus*; b, *nigricornis*; c, *latipennis*.

Adult (Plate XXX, fig. 6).— Body slender. Long axis of head in life nearly horizontal. Pronotum slightly elongated; disk narrowed in front; sides nearly vertical at hind edge, flaring outward in front part. Abdomen composed of ten segments, including the last which bears the cerci and anus. First segment much reduced ventrally. Antennæ filiform; over twice the length of body. Legs slender; hind femora a little thickened. Hind tibiæ with a double row of teeth on posterior side, intermixed on distal half with longer spines; with three pairs of spurs at the tip. Anterior tibiæ with a tympanum near the base.

The hind wings of both sexes are folded and generally extend beyond the tip of the fore wings.

Males have the fore wings much broader than body. A longitudinal fold occurs about one-third way from the costal margin; the inner two-thirds lies horizontally over the back and the remainder is deflexed toward the sides.

The fore wings of the female are regularly reticulated, much narrower than those of the male, and are wrapped closely around the body. A longitudinal bend of about ninety degrees is located about half way between the two margins.

HATCHING.

The time of hatching seems to be fairly uniform for the four species of which data on this process were obtained, namely *Œ. niveus*, *angustipennis*, *nigricornis* and *quadripunctatus*. For average years in western New York it begins from the tenth to the middle of June and the insects may continue to appear until about the twentieth of that month. Farther south the time of hatching is correspondingly earlier.

The process of hatching is best explained by the accompanying figure (Fig. 21). The egg becomes slightly swollen, preceding the period of hatching, apparently due to an increase in internal pressure. The end of the cap breaks off, and the embryo slips out (Fig. 21, b). It retains its embryonic form until about half way out, then the thorax becomes strongly arched upward (Fig. 21, c, d). The nymph continues to work itself out by muscular contractions of the abdomen and by moving the body up and down and from side to side. A delicate membrane projects from the egg puncture and clings to the body, making it difficult for the nymph to free the hind legs and antennæ. The latter are finally grasped by the mouth parts and worked out by movements of the head (Fig. 21, e). Within about ten or twelve minutes the nymph is free and crawls upward on the plant. A prominent watery bump on the head, which formerly filled out the end of the egg, gradually diminishes in size and within half an hour is not apparent. Some nymphs never succeed in freeing themselves from the egg and these are often devoured by their more fortunate companions.

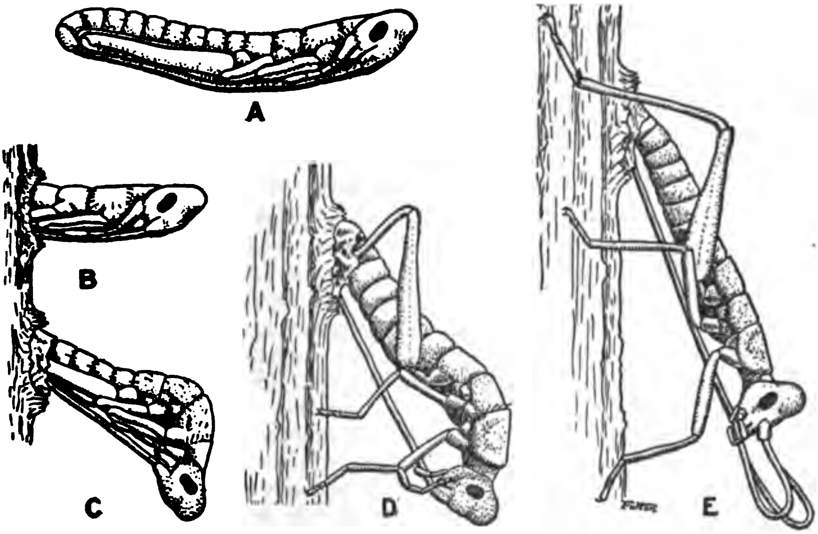

FIG. 21.— HATCHING OF TREE CRICKETS.
a, Position of embryo in egg; b, c, d, e, Successive stages in emergence of nymph.
Drawings made from *Œ. quadripunctatus*.

In all cases observed the ventral side of the embryo lies next to the outer curve of the egg, thus if the egg curves downward in the plant, the embryo will emerge ventral side up. The eggs of *Œ. quadripunctatus* generally turn upward in the stalk, while those of

Œ. nigricornis turn downward in nearly all cases. The eggs of the other species turn downward much more often than upward.

MOLTING.

When a nymph prepares to molt, it first fastens its claws firmly in the bark or in the tissues of a leaf, extends the antennæ backward and arches up the back. The skin splits along the dorsal median line of the head and thorax. The head is bent down and the thorax works out through the split. The fore and middle legs are pulled out and exercised, while the palpi and antennæ are still held in the skin. The hind legs are pulled upward and forward. The antennæ are partly pulled out by straightening the body, and then they are grasped by the mouth and worked out in the same manner as noted in the process of hatching. When the hind legs are free the nymph grasps the support and pulls out the hind part of the abdomen. Later the skin is eaten by the insect if in the meantime the discarded remnant has not been consumed by some other cricket.

FEEDING HABITS.

The food of the crickets consists of a great variety of materials of both plant and animal origin, which are soft enough to be masticated by their comparatively weak mandibles. In the breeding cages the crickets were fed almost entirely on plant lice, which were readily available and on which the crickets seemed to thrive well. Any cricket which was injured or in any way unable to defend itself was generally devoured by its companions. They also ate numerous small holes in raspberry leaves, and chewed at the cambium layer of apple branches in places where it was exposed by a cut. They ate the anthers and other floral parts of the wild carrot (*Daucus carota*) and also chewed out patches of the outer tissue of the stalks. Tree crickets confined on branches with ripe peaches and plums ate round holes in the sides large enough to insert their heads in order that they might feed on the inner pulp. They would also subsist on slices of ripe apples placed in the breeding cages, but at no time did they touch the whole fruit that was sound, apparently being unable to penetrate the outer skin. Tree crickets in the breeding cages readily fed on San José scale on badly infested apple branches. They devoured both the protective covering or scale and the insect itself. One nymph of *niveus* in the fourth stage, which was confined to this diet, ate on an average about four hundred scales during a night, counting both mature and immature insects, and on one night devoured over nine hundred individuals of this coccid.

For further information on the natural feeding habits of the tree crickets, the crops of a number of specimens of *niveus* and *angustipennis*, from apple and *nigricornis* from raspberry, were dissected out and the contents examined under a microscope. In most specimens a large part of the diet consisted of plant tissue in which could be recognized chlorophyll-bearing cells, leaf hairs, vascular tissue, mycelia and spores of various fungi. Crops from *niveus* and *angustipennis* usually contained a small amount of insect material, and in some specimens this was the main constituent. In many cases, it was possible to detect parts of aphids, scale insects and what appeared to be the cast skins of the crickets although these materials were usually much broken up and barely recognizable. Two crops contained a few lepidopterous wing scales and in another the leg and wing of a small hymenopterous insect were detected. Specimens of *nigricornis* always appeared to feed more extensively on plant tissue, although in some specimens a few insect remains could be distinguished.

DIGESTIVE ORGANS.

The digestive organs of tree crickets have some peculiarities worthy of notice. The crop (Fig. 22, d) is large and thin walled and reaches to about the middle of the body; the proventriculus (Fig. 22, e) is spherical and lies between the two anterior lobes of the stomach. The ventriculus or stomach is divided by a constriction into two parts; the anterior, thick walled portion (Fig. 22, f) bears two cœca at the anterior end and one on the right side about the middle; the posterior, thin walled portion (Fig. 22, h) bears a cœcum at the anterior end; the posterior end suddenly narrows down before passing into the hind intestine. At this point a small duct enters (Fig. 22, i) which arises at the junction of the numerous, long malpighian tubes (Fig. 22, g). The proctodæum or hind intestine is short and has only one bend in it (Fig. 22, j).

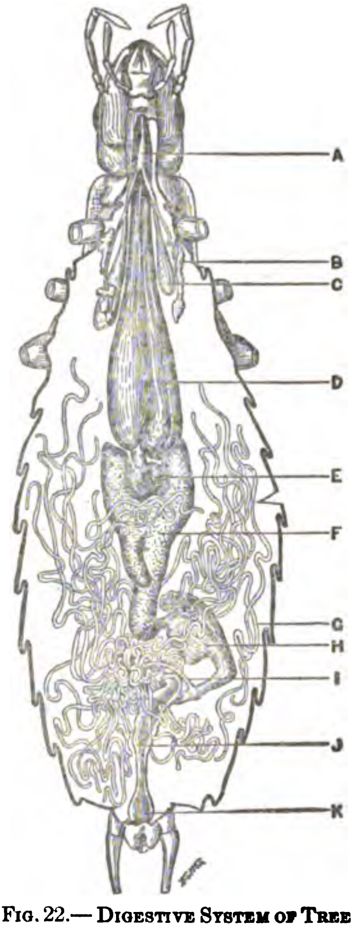

FIG. 22.— DIGESTIVE SYSTEM OF TREE CRICKETS.

a, Common salivary duct; b, salivary gland; c, salivary reservoir; d, crop; e, proventriculus; f, fore part of ventriculus; g, malpighian tube; h, hind part of ventriculus; i, common duct from malpighian tubes; j, hind intestine; k, rectum.

The pair of salivary glands lie in the thorax (Fig. 22, b). The ducts from each receive a branch from the associated thin walled reservoir (Fig. 22, c) and unite under the œsophagus into a common salivary duct (Fig. 22, a) which opens under the hypopharynx.

MUSICAL ORGANS AND SONG PRODUCTION.

The songs of tree crickets form a considerable part of the insect sounds to be heard in late summer and autumn. The males generally place themselves in some hidden retreat among the leaves, with only their long antennæ projecting to warn them of approaching dangers. They stop singing at the slightest jar of the ground or movement of the plants in which they are located, but at night a strong light can be thrown on them without appreciably disturbing them.

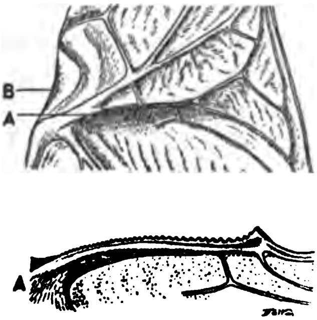

FIG. 23.— LEFT WING OF Œ. *latipennis*, SHOWING RASP (A) AND SCRAPER (B).

In preparing to sing the male raises the fore wings or tegmina perpendicular to the body. This movement automatically unfolds them so that the inner portion, which normally lies horizontally over the back, and the inflexed outer portion, come to lie in the same plane when the wings are raised. The sound is produced by the fore wings vibrating rapidly in a transverse direction, so that the overlapping inner portions rub against each other.

The mechanism which produces the sound is found near the base of the wing, the broad expanded distal part serving as a resonator to increase the volume of sound. A short but prominent transverse vein, about one-fourth way from the base, is modified beneath to form a minute filiform rasp (Fig. 23, a). It is from one to one and a half millimeters long, according to species, and bears from twenty to fifty short teeth which are inclined slightly toward the opposite wing. In all of many specimens examined the right wing laps over the left. The latter has a fine thickened ridge along the inner edge just opposite the file (Fig. 6, b). This scrapes against the teeth of the file on the right wing and thus produces the sound vibrations. The underside of the left wing has a file practically identical to the other but this is apparently seldom, if ever, used. In fact it is doubtful if it ever could be used, for the scraper on the right wing is imperfectly formed and in most cases at least lacks the chitinous ridge along the edge.

MATING HABITS.

The peculiar mating habits of the Gryllidæ have aroused the interest of a number of entomologists both in this country and in

Europe. The first careful and detailed study of the subject was made by Lespès(2, 3) in 1855. In recent years their activities in this respect have been carefully considered by Hancock,(30, 42) Houghton,(34, 35) Baumgartner(40) and Jensen(36, 43) in this country and by Cholodkovsky,(41) Boldyrev(46) and Engelhardt(48) in Russia. My own observations show that the mating habits of *Œcanthus* are similar in many respects to those of *Gryllus* and *Nemobius* as studied by Baumgartner.

The male calls vigorously until a female comes near him, in which case he sidles toward her, without any cessation in his singing and keeping his head in an opposed direction. If he succeeds in attracting her attention she climbs over his body and begins to feed on the secretion of a glandular cavity on the metanotum, which is described by Hancock as an "alluring gland." The male stands with legs spread wide apart and the tegmina are held at an angle of about 45 degrees above the abdomen (Plate XXXI, Fig. 1). His body sways and twitches considerably and the hind wings, which lie folded along the back have a peculiar jerky movement whenever the female bites at the gland. The antennæ are waved about wildly and are often thrown back so as to cross and rub against those of the female. After about half an hour, the male reaches back with his abdomen and the female bends her abdomen downward. This enables him to slip a pair of small, laterally compressed blades into the notch at the tip of the female's subgenital plate. (Fig. 24.) At this time the barbed capillary tube of a spermatophore is pushed into the vagina and when the tip of the abdomen is withdrawn the bulb of the spermatophore is drawn out of its pocket in the male and remains fastened to the female. The latter does not leave immediately but continues to partake of the secretion of the gland for a half hour or more. She finally crawls away to some secluded spot and arches up her back, bringing the tip of the abdomen forward beneath and pulls off the spermatophore with her mouth. She straightens out again and proceeds to eat the capsule in a leisurely way, after which she doubles up again and works at the ovipositor with her mouth, as if endeavoring to clean it.

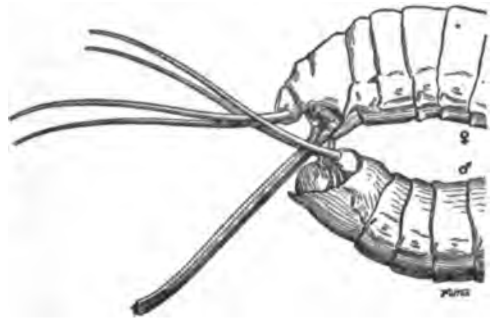

FIG. 24.— POSITION OF BODIES OF MALE AND FEMALE WHILE TRANSFERRING SPERMATOPHORE.

In fastening the spermatophore to the female, the male places his cerci on opposite sides of the ovipositor, and they appear to guide him in striking the proper opening. A male from which both cerci had been removed at the base, was observed trying to copulate. When he succeeded in striking the base of the ovipositor, the female turned the tip of the abdomen down as usual. The male then passed the pair of chitinous blades up and down the ovipositor but was unable to strike the opening at the base and after several attempts the pair became separated.

METANOTAL GLAND.

The exact function of the gland on the metanotum of the male has been a matter of doubt. Hancock(29) first described it as an "alluring gland," claiming that it served to attract and hold the attention of the female until copulation could take place. Boldyrev(46) and Engelhardt(48) of Moscow, Russia, have concluded from observations on the European species, *Œ. pellucens* Scop., that its chief function is to hold the attention of the female after the spermatophore has been attached, and thus prevent her from devouring it before the sperms have had time to pass into the seminal receptacle. These two theories are not diametrically opposed, and from my own observations it seems that the gland may serve both purposes equally well. In no instance did the male transfer the spermatophore before the pair had been together less than a quarter or half an hour. During both periods, before and after passing the spermatophore, the female would occasionally start to crawl away. At such times the male would begin to sing and follow after her, placing himself in front of her and taking such a position as to expose the alluring gland. Usually the female would return, but sometimes she would leave to stay, even before the spermatophore had been fastened to her. Considering the length of time for the first part of the mating process, and the willingness with which the female departs from the male, it seems doubtful if the male, without the help of the gland, could hold the attention of the female long enough to place the spermatophore in the genital opening. On the other hand, the female devours the spermatophore very soon after leaving the male, and if the insects separated immediately after the spermatophore was given over, only a small part of the sperms would have time to flow into the seminal receptacle.

In this connection it is of interest to note that a female nymph of the fifth instar was at one time observed eagerly feeding on the gland of a mature male. This behavior of the nymph would indicate that the mature females probably have a taste for the secretion of the metanotal gland independent of the act of copulation with the male.

Externally the metanotal gland appears as a triangular depression situated in the center of a broad rounded disk, between the bases of the hind pair of wings (Fig. 25 and Fig. 27, a). Most of the surface of the disk is thinly clothed with long delicate hairs. The triangular hollow, the apex of which is directed anteriorly, is densely clothed with shorter hairs. On the sides are two paired rows of larger curved bristles. The hairs of the anterior row are distinctly separated and do not reach to the median line (Fig. 25, b). The posterior row forms a dense brush which reaches to the median line, and at the tip the bristles curve sharply forward and then point backward. (Fig. 25, c.) Two pairs of openings can be discerned with difficulty; the anterior pair on the sides of the depression just above the anterior ends of the first row of bristles (Fig. 25, a) and the second pair in the transverse suture at the extreme posterior edge of the depression (Fig. 25, d).

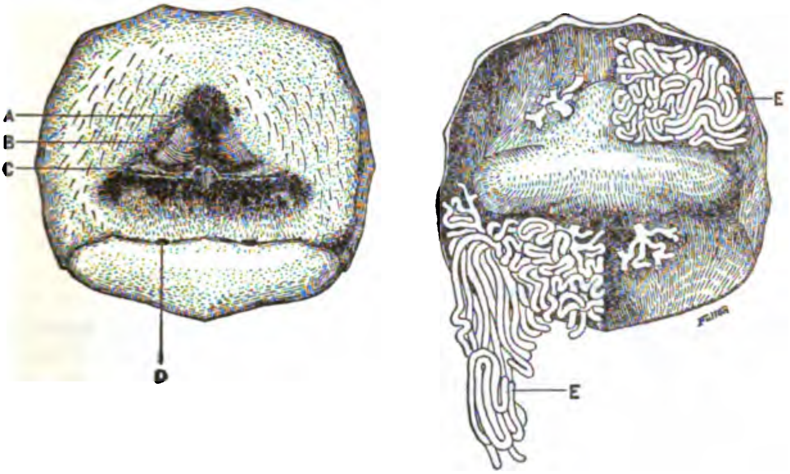

FIG. 25.— METANOTAL GLAND.
Left, dorsal view; right, ventral view of internal structures; a, Opening of anterior tubular gland; b, anterior tuft of hairs; c, posterior tuft; d, opening of posterior tubular gland; e, tubular glands.

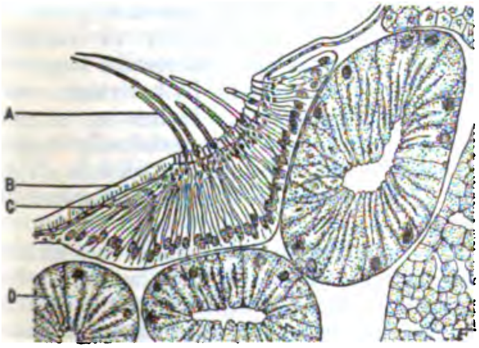

FIG. 26.— METANOTAL GLAND.
Section through anterior tuft of hairs; a, hair; b. cuticle; c, hypodermis cells; d, tubular gland.

By dissection it can be shown that these paired openings lead from much branched internal glands (Fig. 25, e, and Fig. 26, d).

These glands occupy most of the space immediately beneath the metanotum and many long tubes from the posterior pair extend back into the abdominal cavity. Stained sections show that the hypodermis underlying the hairy parts of the gland is unusually thick and that it is composed of long spindle- or club-shaped glandular cells (Fig. 26, c). Certain of these cells pass through minute pores in the chitinous cuticula (Fig. 26, b) and into the hairs (Fig. 26, a), which contain a cavity running clear to the tip. Other minute pores open out between the bases of the hairs. The larger hairs bear several spindle-shaped nuclei. All of the hairs on the interior of the cavity appear to be glandular but the largest cells are found under the two paired tufts of bristles as described above.

DESCRIPTION OF THE SPERMATOPHORE.

The spermatophore is ovoid in shape, with one end tapering into a conical neck which terminates in a long capillary tube (Fig. 28, v). The main body varies somewhat in size with the different species, from about .6 mm. long and .5 mm. wide in *Œ. angustipennis* to about 1.1 mm. long and .9 mm. wide in *Œ. latipennis*. The wall consists of two translucent coats. The outer (Fig. 28, m) is white and rather easily crushed and forms only a thin film at the tube end, but gradually becomes very thick at the opposite end; and it is this that gives the spermatophore its oval shape. The inner coat (Fig. 28, k) which forms a nearly spherical body, is very hard and firm, of a pale brown color, darker near the inner cavity and has a uniform thickness of about one-sixth the entire diameter of the spermatophore. The inner cavity (Fig. 28, j) is filled with sperms at first but if the spermatophore is removed from the female after mating, it is nearly or entirely empty. The tube is nearly one and one-half millimeters long and is bent in the form of a hook, with the distal half straight and pointing back over the main body (Fig. 28, e). It has an outside diameter of about .03 mm. near the base and gradually tapers to a very fine point. Just distal to the bend of the tube is a thin blade-like barb. The cavity of the body of the spermatophore is continuous with that of the tube.

When the spermatophore is fastened to the female the sperms start to pass out rapidly through the tube. I have watched this process in the spermatophore of *Gryllus pennsylvanicus* but not in the spermatophore of *Œcanthus* species. The spermatophore was removed from the male and placed on a slide with a little water around the tip of the tube but not around the bulb. A granular looking substance came out slowly at first. Then the spermatozoa began suddenly to shoot out rapidly through the tube, which was so small as to allow only a few to pass through side by side After about fifteen minutes the sperms were all out and these were followed by a brownish substance which was discharged for a short time. The bulb of the spermatophore did not collapse and seemed to retain its normal size after the loss of its contents.

MALE REPRODUCTIVE ORGANS.

The testes are irregularly oval, pale yellow bodies located in the anterior part of the abdomen (Fig. 27, b.). The seminiferous tubules, of which each one is made up, converge into a sinus near the anterior end. The vas deferens is a minute tube which runs from the sinus back between the tubules and emerges near the posterior end of the organ (Fig. 27, c, and Fig. 28, d). It continues along the side of the body to the posterior extremity where it turns forward and becomes much enlarged and coiled, forming an oval body surrounded by yellow fatty tissue (Fig. 27, g, and Fig. 28, c, g). This enlarged portion is filled with sperms and no doubt serves the function of a seminal vesicle. The short remaining portion of the vas deferens is straight and of larger diameter, and continues anteriorly to join the large sinus into which hundreds of glandular tubules empty (Fig. 10, d, and Fig. 28, b). These tubules are filled with a homogeneous substance which probably forms the wall of the spermatophore. From the sinus a large common duct (Fig. 27, e) leads to the spermatophore mold at the end of the abdomen (Fig. 27, h). That this duct is not a true ejaculatory duct, either in origin or function, has been pointed out by Baumgartner in his work on *Gryllus*. It arises as an invagination from the outside and is not used as a sperm carrier during copulation.

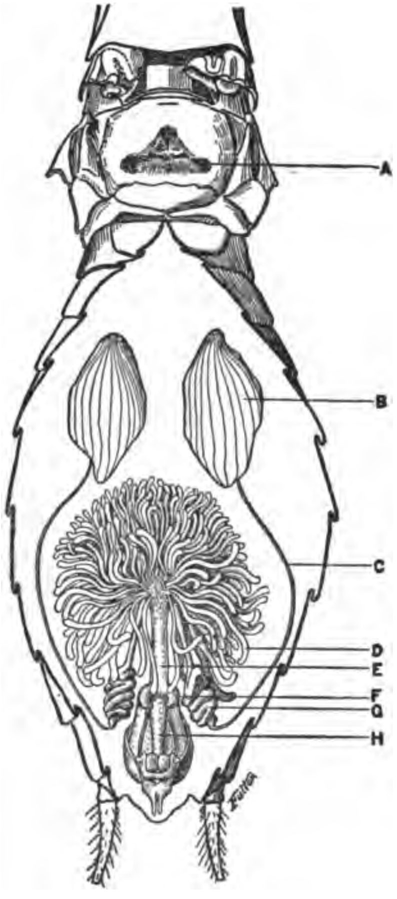

FIG. 27.—MALE REPRODUCTIVE ORGANS.

a, Metanotal gland; b, testis; c, vas deferens; d, glandular tubule; e, common duct; f, accessory pouch; g, enlarged portion of vas deferens; h, spermatophore mold.

The spermatophore mold lies in the ninth abdominal segment, the sternum of which forms the large subgenital plate. The part of the wall of the mold which contains the body of the spermatophore consists of two pliable flaps which meet on the median line dorsally and ventrally. These are collapsed when empty but conform to the bulb of the spermatophore when one is present (Fig. 28, l). At the anterior end a groove or out-pocket of the mold starts in and passes first dorsally and then posteriorly (Fig. 28, f). This groove is supported by chitinous walls and terminates in a sharp point, and just before the tip it bears a pair of horizontal wings which together resemble a fish-tail in shape. The groove holds the tube of the spermatophore (Fig. 28, e). On each side at the level of the groove is a movable, spoon-shaped piece, which is three-lobed at the tip and connects with the groove support at the base (Fig. 28, o). Dorsal and posterior to the end of the groove is a pair of laterally compressed, blade-like appendages which lie close together and

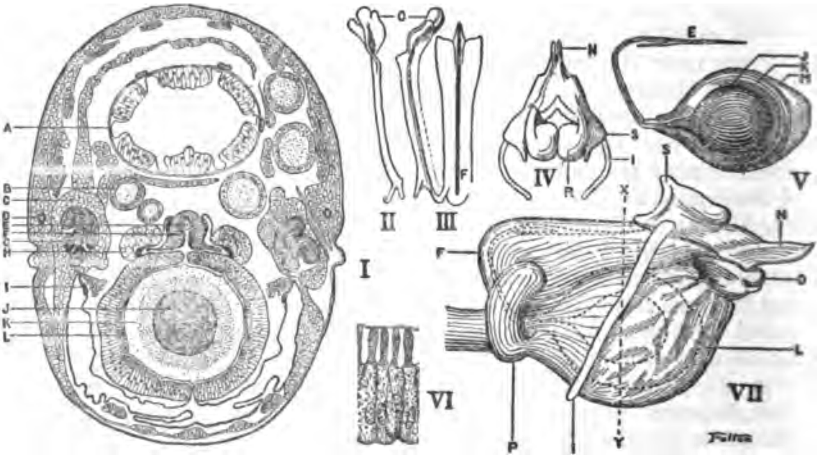

FIG. 28.— MALE REPRODUCTIVE ORGANS: I, CROSS SECTION OF ABDOMEN THROUGH SPERMATOPHORE MOLD. II, LATERAL VIEW OF TRI-LOBED, PADDLE-SHAPED STRUCTURE. III, VENTRAL VIEW OF SAME AND GROOVE OF SPERMATOPHORE MOLD. IV, VENTRAL VIEW OF COPULATORY BLADES AND BASAL STRUCTURE. V, SPERMATOPHORE. VI, PORTION OF EPITHELIUM SURROUNDING SPERMATOPHORE. VII, LATERAL VIEW OF SPERMATOPHORE MOLD.

a, Rectum; b, glandular tubule; c, fat-tissue; d, vas deferens; e, spermatophore tube; f, groove of spermatophore mold; g, enlarged portion of vas deferens; h, muscle; i, chitinous supporting rod; j, sperm cavity; k, inner layer of spermatophore wall; l, wall of spermatophore mold; m, outer layer of spermatophore wall; n, copulatory blades; o, paired paddle-shaped structure; p, accessory pouch; r, paired cavity and tube running into copulatory blade; s, basal structure and point of attachment; x-y, location of accompanying cross section.

terminate in a slightly hooked point (Fig. 28, n). These blades are inserted into the genital opening of the female when the spermatophore is transferred. At the base they widen out and are united on the median line. Still farther anteriorly the heavily chitinized part divides into two large basal structures, which are connected with the posterior edge of the lateral walls of the ninth segment and constitute the main supporting structure of the spermatophore mold (Fig. 28, s). Between these structures near the median line is a pair of closed cavities, each with a tube extending posteriorly into the corresponding blade-like appendage to near its tip (Fig. 28, r). If these tubes have an opening in the blade it is very minute and could not be detected. A pair of curved chitinous rods are attached to the basal structure and extend obliquely around the mold to nearly the ventral median line (Fig. 28, i) and help support the soft flaps covering the body of the spermatophore. A pair of elongated pouches arise at the junction of the spermatophore mold and the common duct, and extend dorsally along the side of the groove (Fig. 28, p). Their function is not known.

Stained sections show that the lining walls of the mold including the groove are formed of a rather thick layer of columnar epithelium (Fig. 28, VI). This is of ectodermic origin and the side next to the inner cavity is bordered by a thin layer of cuticle which becomes thicker in parts of the groove. The cells show a peculiar, sharply demarked differentiation of the ends toward the inner cavity, where about one-third of the length is much narrower and rod-shaped, and the intervening spaces are wide. This narrow part is darkly and uniformly stained while the wide nucleated portion has a granular appearance.

FORMATION OF THE SPERMATOPHORE.

The exact process of spermatophore formation is as yet only a matter of conjecture. It seems very probable, however, that a mass of sperms which have collected in the enlarged portion of the vas deferens move out into the mold and are later surrounded by a quantity of secretion from the glandular tubules which hardens around them and in some way forms the spermatophore. The tube is probably formed in the groove, but why it develops as a tube and not as a solid rod is a mystery.

A new spermatophore is usually formed soon after the last one is removed. In mating it was observed that in about ten minutes after the spermatophore is passed to the female and while the latter is still feeding at the metanotal gland, the collapsed mold begins to swell out and in another minute or so is fully distended and remains so. In one case a male was examined about half an hour after the mold became distended. The mold contained a white, globular mass of sperms with a long attenuated thread at one end. It appeared to be enclosed in a delicate membrane although this could not be distinguished. It was surrounded by a clear viscid liquid of about the consistency of egg albumen. I removed the sperm mass with forceps and the liquid began to congeal. A small drop on the point of a needle could be pulled out into a very fine thread which would harden very quickly. The hardening continued even after the mass was placed under water and resulted in a hard substance like the wall of the spermatophore.

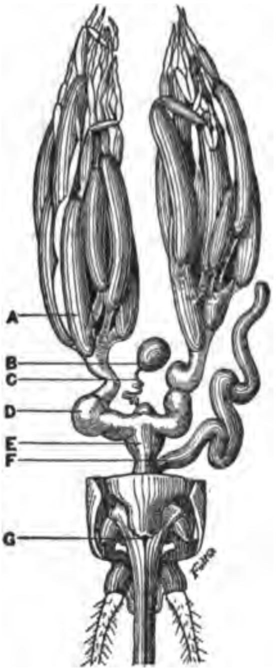

Fig. 29.— Female Reproductive Organs.
a, Ovary; b, seminal receptacle; c, duct leading to seminal receptacle; d, oviduct; e, vagina; f, accessory gland; g, copulatory opening.

Another male which had disposed of a spermatophore was examined in an hour and three-quarters after the mold had become distended and it was found to contain a fully formed and hardened spermatophore.

FEMALE REPRODUCTIVE ORGANS.

In order to follow the course of the sperms after the deposition of the spermatophore it is necessary to understand a little of the anatomy of the female reproductive system. The ovaries occupy a large portion of the central part of the abdominal cavity. They are made up of a large number of separate egg tubes, each of which contains several ovarian follicles in various stages of development (Fig. 29, a). The tubes all converge into the broad, thin-walled oviduct (Fig. 29, d) and these unite to form the vagina (Fig. 29, e) which continues as a straight tube to the ovipositor. A single tubular accessory gland (Fig. 29, f) opens above the vagina at the base of two short rods which are between and hidden by the four large rods of the ovipositor. This gland probably furnishes the mucilaginous substance exuded at the time of oviposition. The notch at the end of the subgenital plate opens into the ventral side of the vagina (Fig. 29, g). Just anterior to this on the dorsal wall of the vagina is a hard plate, which is slightly hollow on the inner side and bears a small hole in the center. This hole passes through and opens on the dorsal side into a small convoluted duct which leads to an ovoid seminal receptacle lying just anterior to the junction of the two oviducts (Fig. 29, b, c).

A female bearing a spermatophore was killed and dissected. The tube was inserted in the notch at the end of the subgenital plate, and the point was directed into the hole in the plate on the dorsal wall of the vagina. It would appear that the sperms discharging through the tube would thus be directed into the duct of the seminal receptacle.

OVIPOSITION.

For this operation the female selects a suitable spot on the plant and prepares to oviposit by first chewing a small hole in the bark. Upon the completion of the cavity she then walks forward a little, arches her back so as to bring the ovipositor about perpendicular to the branch and begins moving it up and down until she strikes the hole. She then starts to drill by giving the ovipositor quick thrusts and at the same time slowly turning it around by twisting the abdomen thirty or forty degrees to each side (Plate XXXI, Fig. 2). It takes from five to twenty-five minutes according to the resistance of the wood, to force the ovipositor to its base the first time. After this it is pulled nearly out and drilled in again several times, each operation requiring from one to five minutes or more. When the hole is sufficiently reamed out and the ovipositor drilled in for the last time, the female rests a moment and then arches up the middle of the abdomen and forces an egg down into the ovipositor. The body quivers and shakes a little during the operation, which lasts about twenty seconds, and then the ovipositor is slowly withdrawn, twisting from side to side. When only the tip remains in the hole the female pauses and discharges a small quantity of mucilaginous substance which fills up the opening. She then removes the ovipositor and plugs up the mouth of the hole, using such material as the instincts of the various species determine. She spends several minutes packing it in and smoothing it out so that the wound is neatly capped. The whole process of oviposition, from chewing the bark to sealing the wound may require from a quarter to nearly a whole hour.

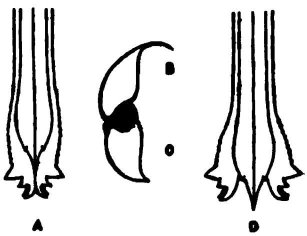

FIG. 30.— OVIPOSITOR.
a, Tip with rods in normal position; b, c, cross section of upper and lower rods on one side; d, position of rods when ventral pair are thrust downward.

The ovipositor is made up of two pairs of long chitinous rods which fit together in such a way as to make a compact organ nearly circular in cross section. It was observed that, in drilling, the upper pair of rods remain stationary except for the twisting movement while the lower pair slide up and down with each thrust. The upper and lower rod on each side can not be separated readily and in cross section it can be seen that they are firmly united by a tongue of the upper fitting into a groove in the lower (Fig. 30, b, c). At the tip the lower pair are wedge shaped and fit in between the ends of the upper pair, which have four stout spurs on each side. When the lower rods are thrust downward their chisel-shaped points push into the bottom of the hole and at the same time they wedge apart the ends of the upper rods causing them to widen the hole (Fig. 30, d).

The ovipositor first makes its appearance in an incipient stage in the second instar in the form of two small rounded projections on the ventral side of both the eighth and ninth abdominal segments. In the third instar it consists of four backward pointing papillæ— the anterior pair being smaller and lying in contact with the lower surface of the hind pair. In the fourth instar it forms a compact body extending a trifle beyond the tip of the abdomen. The sterna of the eighth and ninth segments are reduced and almost completely taken up by their appendages. In the fifth instar the ovipositor is much longer and bears much resemblance to the adult organ. The sternum of the seventh segment is enlarged and forms the subgenital plate.

KEY TO EGGS AND OVIPOSITION HABITS OF THE TREE CRICKETS.

- A Eggs white or only slightly yellowish; deposited singly in the bark or cambium of trees and bushes.
    - B Egg cap with long finger-shaped projections. *niveus*
    - BB Egg cap with knob-like projections, not much longer than thick. *angustipennis*
    - BBB Egg cap with low rounded elevations. *exclamationis*
- AA Eggs yellow; deposited in rows, and lie in the pith of stems of herbaceous plants and twigs or small branches of woody plants.
    - B Eggs in loose rows, in small herbaceous stems, 5 mm. or less in diameter. Projections of cap, finger- or club-shaped. *quadripunctatus*
    - BB Eggs in compact rows, in stems 5 mm. or over in diameter. Projections of cap with length not more than one and a half times the width. *nigricornis*
    - BBB Eggs in pine twigs. Projections of cap transversely elliptical in cross section. *pini*
- AAA Eggs pale yellow; deposited in two groups in the pith, one cluster on each side of the hole made in the outer woody layer of the stem. The holes may be in rows but in such case are a centimeter or more apart. *latipennis*

ŒCANTHUS NIVEUS De Geer

HISTORICAL NOTES.

This insect was described from a Pennsylvania specimen as early as 1773 by De Geer,(1) who called it *Gryllus niveus*. Its status has been clearly established in systematic literature but in economic writings it has long been confused with *nigricornis* and regarded as the cause of an oviposition injury to raspberries performed by the latter species. Walsh(6) and Riley(7) evidently did not distinguish between the two species for both describe partly black varieties which never occur in *niveus*. Later Riley(10) states that he considers both *nigricornis* and *fasciatus*, which are synonymous, as dark varieties of *niveus*. The uncertainty as to the identity of these species by economic writers has probably led to the subsequent confusion concerning their oviposition habits, which still persists to a less degree.

DISTRIBUTION.

From available records *niveus* is the most generally distributed of the species occurring in the United States, ranging from Massachusetts to the Pacific Coast and from the Province of Ontario on the north to as far as Mexico on the south It is found all over the State of New York with the exception of forested regions in the northeastern part. It has been recorded in literature from the following states: Massachusetts (Faxon), Connecticut (Walden), New Jersey (Davis), Ontario (Walker), Georgia (Allard), Indiana (Blatchley), Illinois (Forbes), Kentucky (Garman), Minnesota (Lugger), Kansas (Tucker), Nebraska (Bruner), Michigan (Allis), Cuernavaca, Morelos, Mexico (Rehn), Cuba (Kirby). From specimens examined we can record its distribution in the following states: Colorado and Utah (Titus), Ohio (Kostir), New Jersey, North Carolina, Connecticut (Amer. Mus.), California (Doane); Maine, one specimen (Patch), Cuba (Cardin). From correspondence we have obtained other records as follows: Texas (Newell), North Carolina (Beutenmüller), California and Washington (Melander).

HABIT.

Œcanthus niveus is a tree- and bush-inhabiting form. It is found most abundantly in apple orchards and is more or less common in plantings of other fruit trees and in raspberry plantations, shrubberies, vines and bushy fence rows. Among forest trees it is less common, although a few can often be heard singing in such places. especially along the edge of a wood. In general this species prefers a cultivated region to a wilderness. However, in orchards that are regularly sprayed with arsenicals the crickets do not become very abundant.

DESCRIPTION OF LIFE STAGES.

Egg (Fig. 31, g).— The egg is about one-ninth of an inch long and from one-sixth to one-fourth as wide. The color is dull white, often with a slight yellowish tinge. The cap (Fig. 31, f) is a little narrower than the main body; its sides are parallel and the end is broadly rounded. In color it is opaque white, but is often stained a reddish color by the bark. The projections on the cap (Fig. 31, e) are long and finger-shaped, having a uniform thickness of about .009 mm. from base to tip, and a length of .020 to .025 mm.

The average measurements of forty specimens of eggs are as follows: length 2.83 mm.; greatest width, .62 mm.; length of cap .51 mm.; width of cap .51 mm.

Nymph.— First instar (Plate I, Fig. 1): Color white. Top of head with two rows of ten to fifteen small bristles, directed anteriorly and each with a small black spot at the base. There is a short black line extending backward from the upper edge of each eye and one or two pairs of brownish transverse spots between the eyes. The pronotum, and sometimes the meso- and metanotum, have a pair of longitudinal brownish stripes situated close to the median line. Basal segment of antenna with a small black spot on the inner side and a brownish spot on the posterior side; second segment with a black transverse line on the inner side; third, fourth, sixth and ninth segments with a narrow black ring at apex; each succeeding segment with faint gray annulation at tip. Hind tibiæ with black spots at the base of the small bristles, especially prominent on the outer and upper sides. Length about 3 mm. Antennæ 6.3 to 7.5 mm.

Second instar (Plate XXX, Fig. 2): Ground color of abdomen transparent greenish white with two rows of pure white blotches on each side of median line. Basal segment of antenna with a round black spot on the front and inner side, and the second segment with a similar spot on the front side and a transverse dash on inner side. Distal part of antennæ with gray annulations on alternate segments. Length 4.5 to 5 mm. Antennæ 10.7 mm.

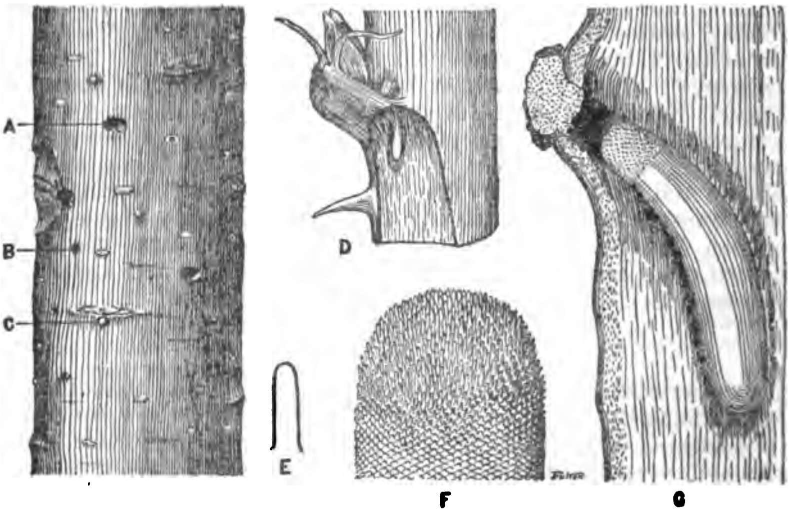

FIG. 31.— *Œcanthus niveus* DE GEER.

a, Egg puncture of previous year healed over, in apple bark; b, recent egg puncture without plug; c, egg puncture with plug (all x 1½); d, egg in raspberry (x 2½); e, projection of egg cap (x 500); f, egg cap (x 50); g, egg in apple bark (x 15).

Third instar (Plate XXX, Fig. 3): General color greenish white. Abdomen with several rows of irregular opaque white blotches on each side of median line. The brownish markings on the head and thorax are very faint. Black spot on first segment of antenna on a white prominence. Length 6 to 7 mm. Antennæ 13 mm.

Fourth instar (Plate XXX, Fig. 4): Coloration practically the same as in the preceding stage. Length 8.5 to 9.5 mm. Antennæ 16 mm.

Fifth instar (Plate XXX, Fig. 5 and Plate XXXII, Fig. b): Color pale yellowish green. Segments of abdomen with a fairly regular pattern of roundish white blotches; a small one on front and one on hind margin on median line; larger blotches on each side are arranged alternately near the front and hind margins. Outer side of hind femur with numerous black spots extending over the distal two-thirds or four-fifths. Antennæ marked similar to adult. Length 11 to 12 mm. Antennæ 23 mm.

Adult (Plate XXX, Fig. 6 and Plate XXXIV, Fig. a): Moderately slender. Pronotum as broad as long. Color very pale green. Top of head between eyes and

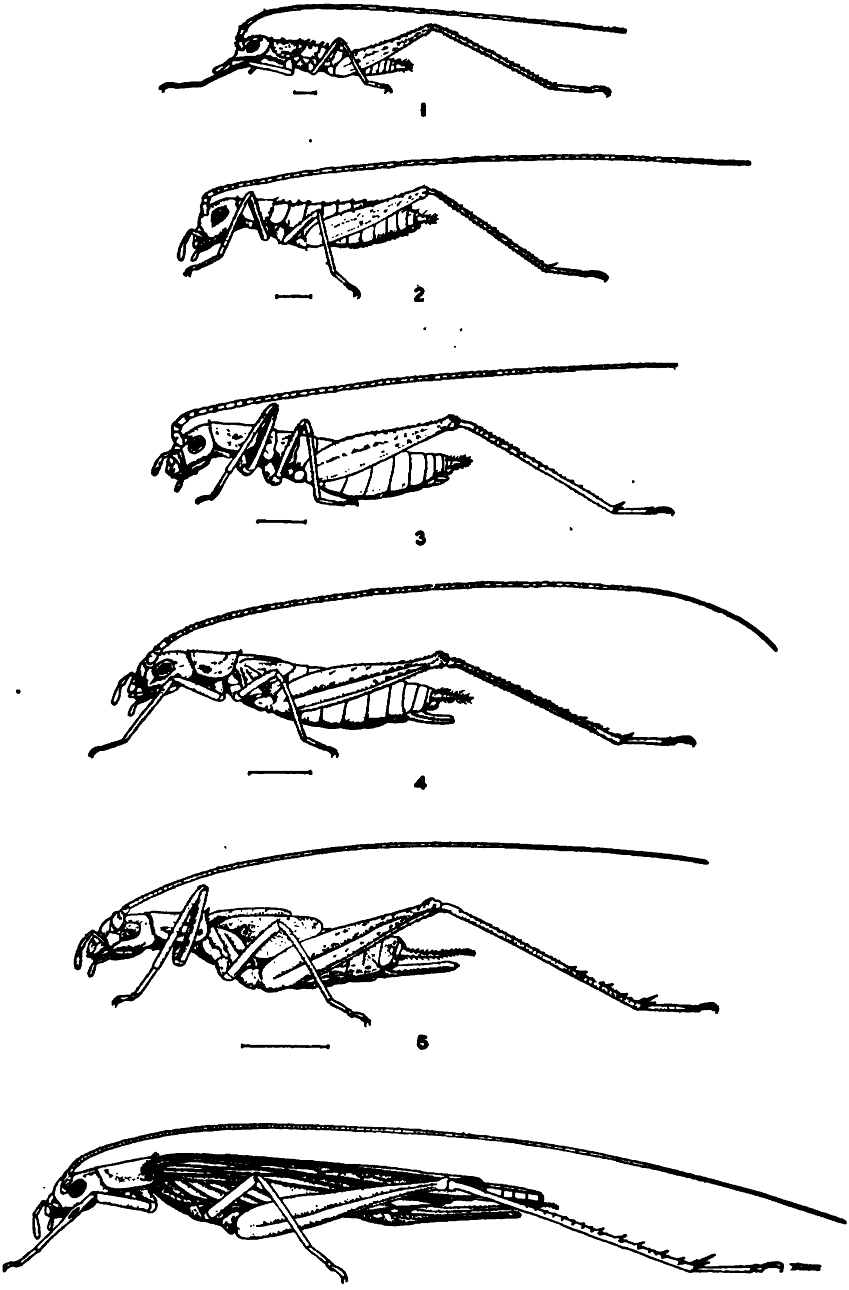

Plate XXX.— Life Stages of *Œcanthus niveus;* Nymphal Instars and Adult.

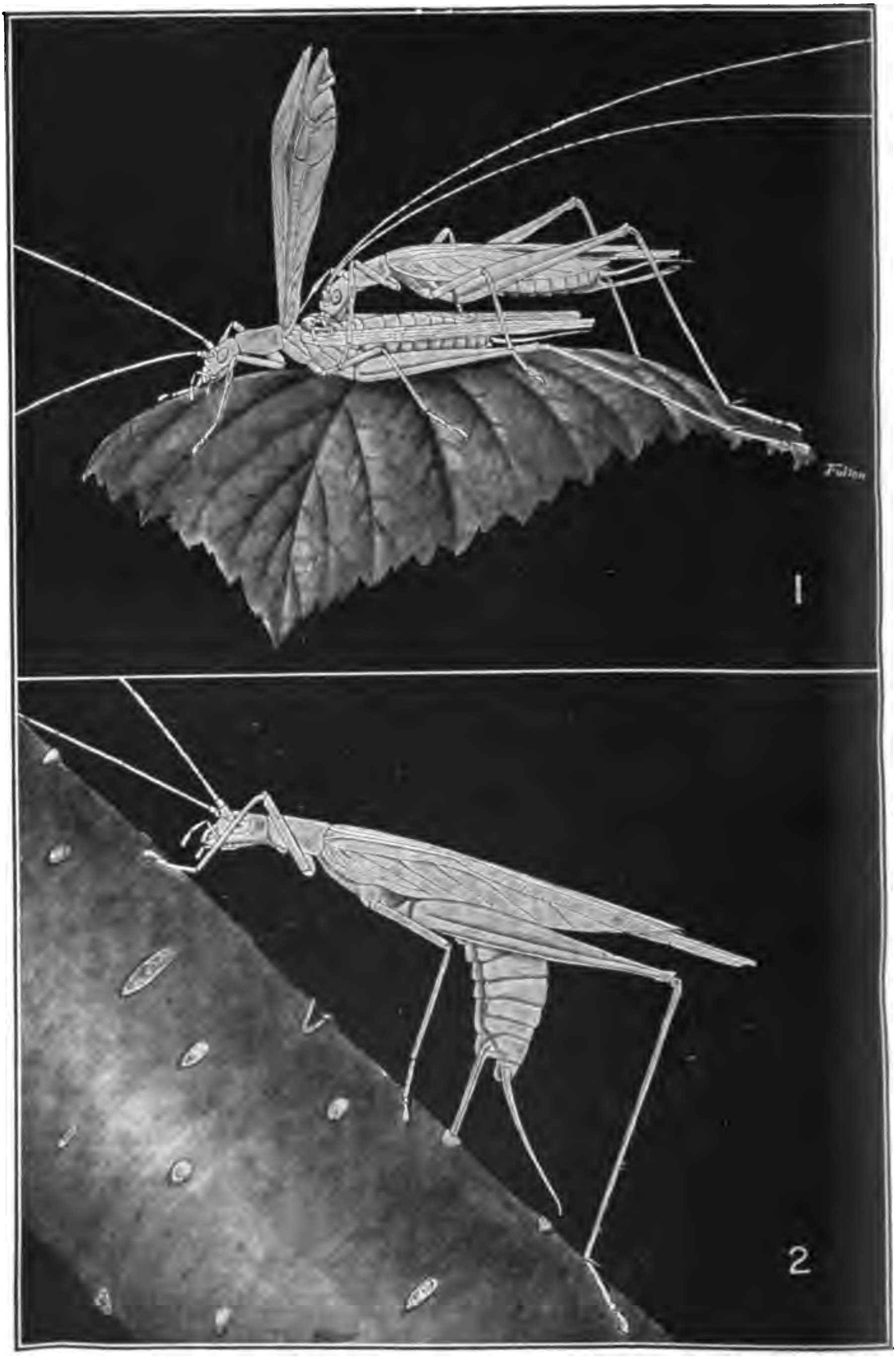

Plate XXXI.— 1, Female of *Œcanthus niveus* Feeding on Metanotal Gland of Male; 2, Characteristic Posture of Female when Ovipositing.

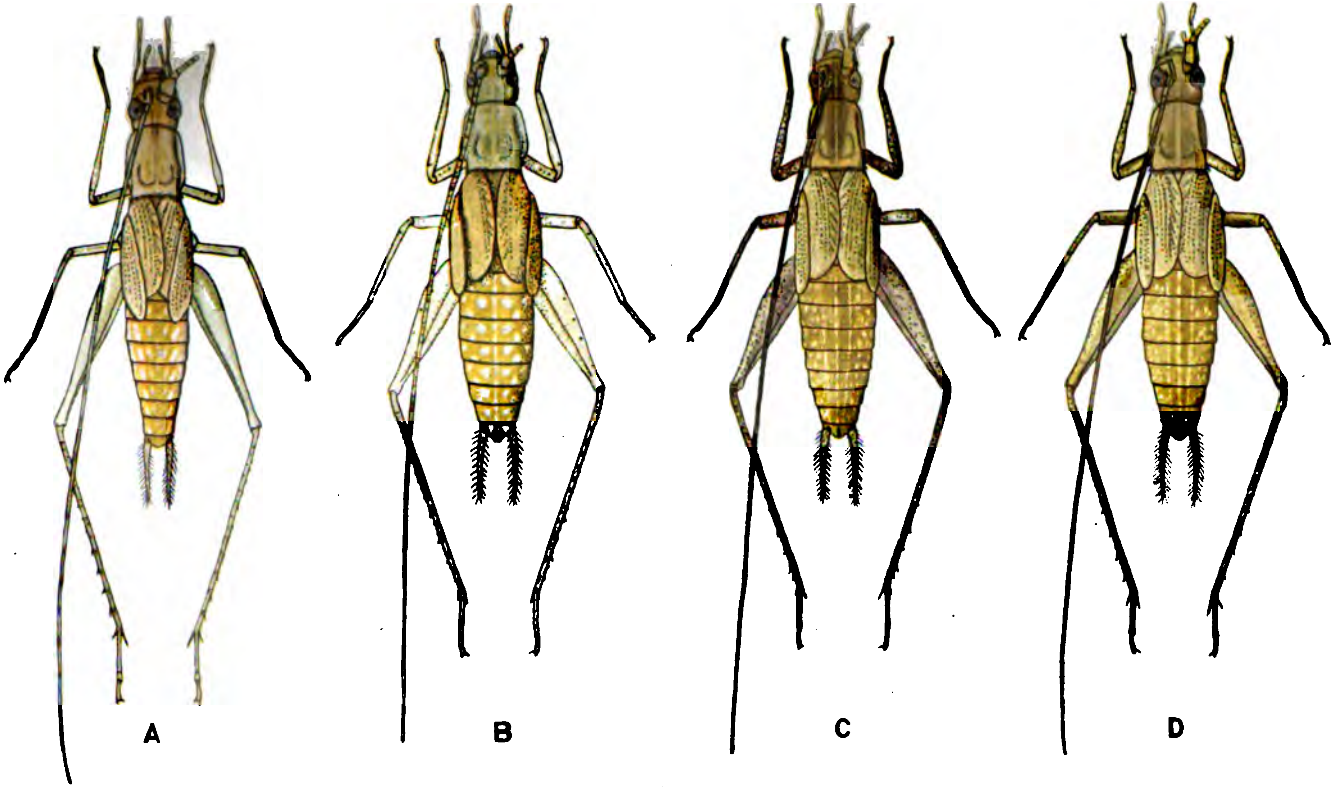

Plate III.— Fifth Stage Nymphs of Tree Crickets: a, *Œcanthus angustipennis;* b, *niveus;* c, *nigricornis;* d, *quadripunctatus.*

PLATE XXXII

UNIV. OF MICH.

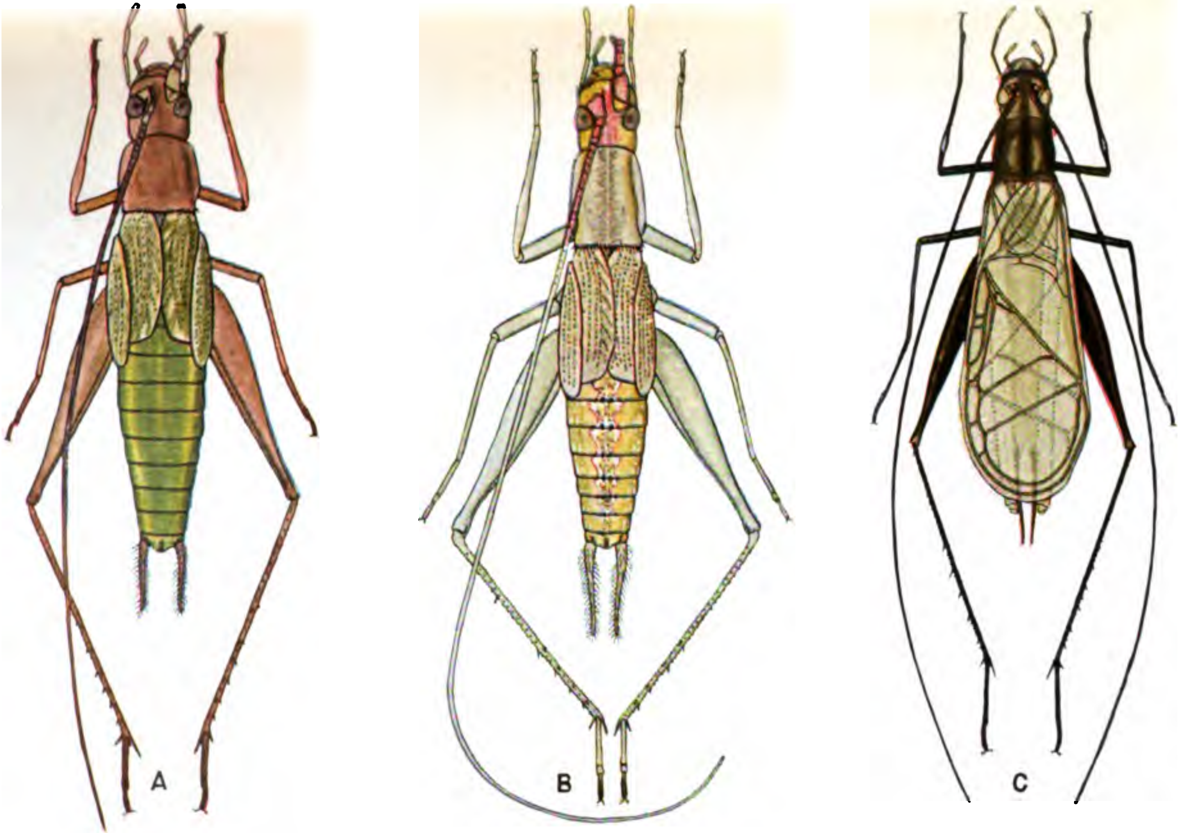

Plate IV.— Fifth Stage Nymphs of Tree Crickets: a, *Œcanthus pini;* b, *latipennis;* c, Adult Male, *nigricornis.*

PLATE XXXIII

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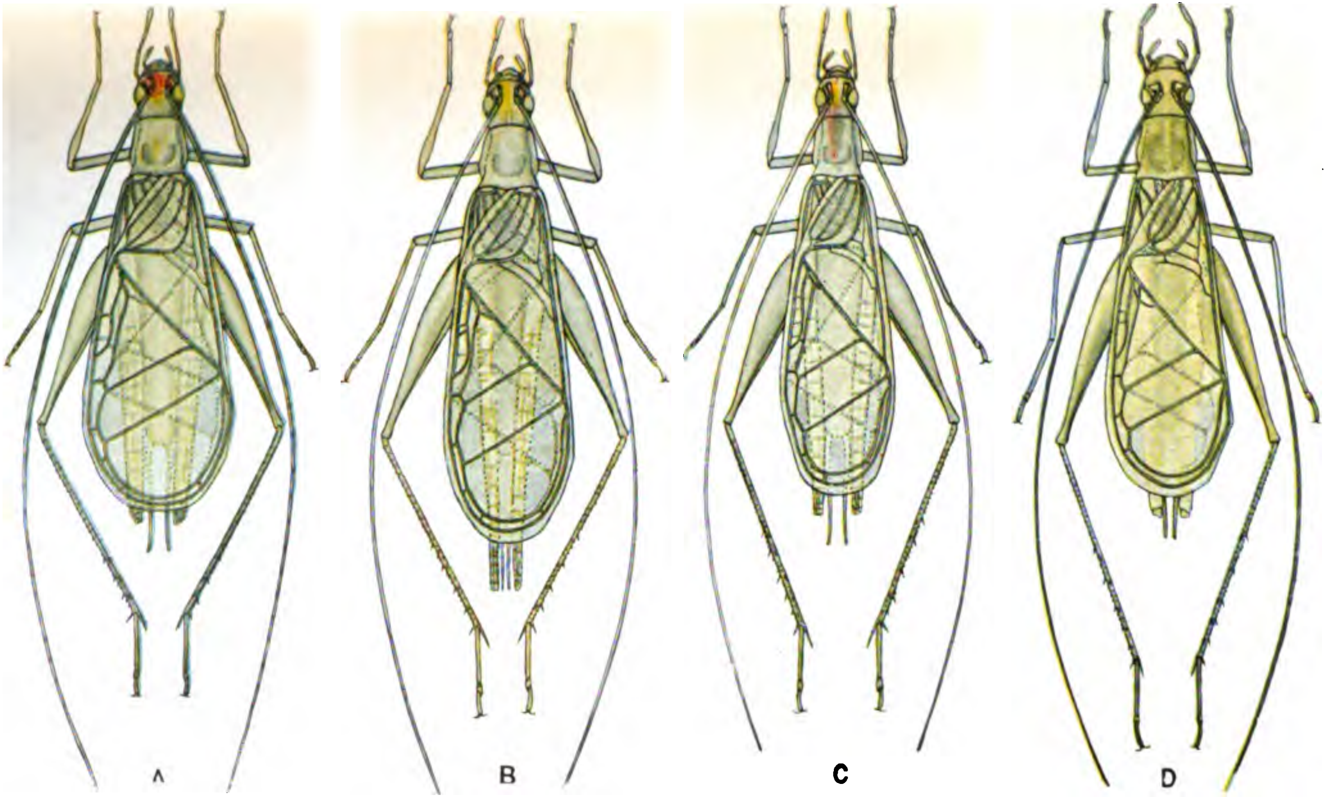

Plate V.—Adult Male Tree Crickets: a, *Œcanthus niveus;* b, *exclamationis;* c, *angustipennis;* d, *quadripunctatus.*

PLATE XXXIV

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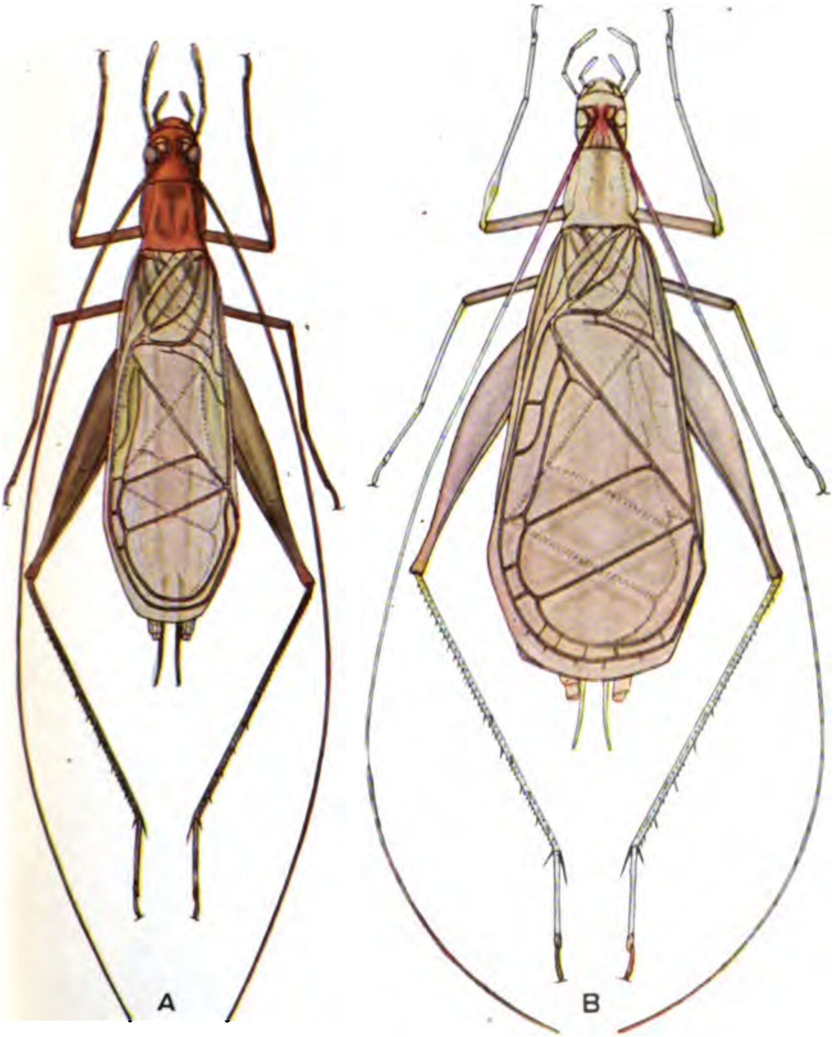

Plate V.— Adult Male Tree Crickets: a, *Œcanthus pini;* b, *latipennis.*

PLATE XXXV

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antennæ orange yellow; occipital area with longitudinal transparent greenish blotches separated by white lines. Wings transparent, with a slight greenish tinge; veins more or less colored with yellowish green. Fore wings of male very broad. Antennæ white, with gray annulations in the distal part at intervals of about four segments. First segment is pale orange yellow on all parts except the large swelling on the front and inner side which is white and has a conspicuous round black spot in the center. (Fig. 1, a.) The second segment is white with a similar spot. Length to end of abdomen 14 mm. Fore wing of male 13–14 mm. x 6 mm. Fore wing of female 12–13 mm.

SONG.

The song of *niveus* is one of the most conspicuous and musical of the insect sounds commonly noted in late summer and autumn. It can be heard from the time the insects commence to mature — early in August in this latitude — until they succumb to frosts of late October or early November. The song begins at the approach of darkness and continues until morning. Occasionally a few of the insects may be heard during the middle of day when the weather is very cloudy. The song consists of a monotonous series of clear, high-pitch trills rhythmically repeated for an indefinite length of time. The quality is that of a clear, mellow whistle and has best been described by the words, *treat — treat — treat.* The pitch varies somewhat with the temperature, but on an ordinary summer evening it is about C, two octaves above middle C, or on a warm evening it may reach as high as D. The rapidity of the notes is directly dependent on the temperature. On a very warm night we counted 155 beats per minute, while on a cool night the number was only 64. This phase of the subject has been studied by Bessey(21), Edes(22) and Shull(23) and formulas have been worked out by which the temperature can be computed from the average number of notes per minute.

The song of different individuals may vary also in quality, intensity, pitch and rapidity of notes. There is, however, a tendency for the insects in a restricted site — as a raspberry plantation, clump of bushes or a single tree or a small clump of trees — to sing in unison in one synchronous movement.

Scudder(15) has described *niveus* as having two distinct songs, one for day and one for night. This certainly is not true, for none of our species have more than one type of song. Scudder made observations on two different species and admits in the same article that at the time he did not distinguish between the species. His " day song " would apply to *nigricornis, quadripunctatus* or possibly *latipennis,* although the last does not usually sing by day. His " night song " describes well the song of *angustipennis.*

OVIPOSITION.

In ovipositing the female *niveus* prefers to stand on the upper side of a branch, and when on a vertical or sloping surface generally works with the head uppermost. Another peculiarity which has been observed in only one other species, namely *exclamationis*, is the use of excrement to plug up the puncture. Just before depositing the egg and while the ovipositor is imbedded for its full length in the bark, the female forces out a drop of excrement, which by stretching out the tip of the abdomen she fastens to the bark just below the hole. After withdrawing the ovipositor she moves back, picks up the drop with her mouth and places it over the opening. Several minutes are then spent in packing it in and smoothing it out (Fig. 31, c).

The eggs are deposited in the soft inner bark of a number of trees and bushes. In most cases a part of the egg lies in contact with the wood, which is grooved by the ovipositor but not drilled into to any extent. In the process of healing, the puncture becomes surrounded, in most plants, by a hard woody callus. In trees having a soft fleshy bark, *niveus* prefers to oviposit in branches from one to three inches in diameter. The eggs may be placed in almost any part of the bark, but the lenticels are favorite places, probably because they are less resistant to the drilling operations.

In bushes and in trees which have a hard bark covering the larger branches, the eggs are commonly laid in the smaller branches in thick places in the bark at the sides of buds or small twigs. In raspberry canes, where this species is sometimes fairly common, the eggs are deposited singly in the fleshy area at the side of the bud in the axil of the leaf, and they never extend through the woody layer into the pith (Fig. 31, d).

In breeding-cage experiments from one to thirteen eggs were deposited in a night by a single individual. A number of the insects laid a few eggs every night during the whole period of oviposition, while others suspended operations on several nights. The largest number of eggs deposited by a single female was seventy-five, the smallest number twenty-four, and the average of eleven individuals was forty-nine.

About Geneva the eggs of *niveus* are found most abundant in apple, plum and cherry trees, and are locally common in walnut and raspberry. One small elm tree was observed to contain a large number of them, and in this case the eggs were deposited in the corky areas of the bark and did not extend into the cambium layer. A few eggs were found in peach, witch-hazel, chestnut, butternut, wild crab-apple, hawthorn, red oak, maple and lilac. Oviposition probably occurs in many other plants which possess bark of desirable thickness and not too resistant to the drilling operations of the insect.

ŒCANTHUS ANGUSTIPENNIS Fitch.

HISTORICAL NOTES.

This name was first applied by Fitch(4) to a single male specimen which he described as a variety of *niveus*. The description is very brief; and the only characters mentioned are that the tegmina are narrower than *niveus* and the hind wings protrude like tails. The latter character strongly suggests *Neoxabea bipunctata*, the male of which was unknown to Fitch, although the description might apply to *Œ. quadripunctatus* or the species now understood by this name. Beutenmüller(17) states that "whether the species has been correctly determined or not can never be definitely ascertained, as Fitch's type of the species, as well as his other species of *Œcanthus*, have been destroyed. I would propose that the name *angustipennis* nevertheless be retained for the species so well known by this name."

DISTRIBUTION.

Our knowledge of the extent of distribution of this species in New York is very limited. It is common in the lake region of the western part of the State and on Long Island, and probably the insect ranges over about the same territory as *niveus*. It has been recorded in literature from other states as follows: Massachusetts (Faxon), Connecticut (Walden), Georgia, Florida, Texas (Allard), Indiana (Blatchley), Illinois (Forbes), Kentucky (Garman), Kansas and Texas (Tucker), Minnesota (Lugger). From specimens examined we can record it from the following states: New Jersey, North Carolina, Florida (Amer. Mus.), Virginia (Schoene), Ohio (Kostir). Of the states mentioned, Minnesota represents the most northern limits of distribution, while Texas appears as the most western area of its occurrence.

HABITAT.

Angustipennis is quite often found in company with *niveus* and is generally abundant in apple orchards. It is more strictly arboreal than the latter species, and seems to be confined to woody plants, either trees or large bushes. About Geneva it has never been taken on raspberry, grape or weeds of any kind. Among forest trees it is more common than *niveus*. Many specimens have been collected from scrub and bur oaks on Long Island and from alder in a swamp near Geneva. Davis(49) states that in Florida he found this species among golden rods and other low plants by the road side and that they also occurred among the small oaks and other trees.

DESCRIPTION OF LIFE STAGES.

Egg (Fig. 32, b).— The eggs are white and average a trifle smaller than those of *niveus*. The cap is narrower than in the latter species and varies greatly in length. Short specimens (Fig. 32, d) measure about .4 mm. in length and breadth, while the long ones (Fig. 32, c) reach .7 mm. in length, have a broad base and taper down to a rather narrow tip. The projections of the cap are short and thick, measuring about .011 mm. in breadth by .014 in length. (Fig. 32, e.) The end of the cap is broadly rounded and the base slightly constricted.

The average measurements of twenty specimens of eggs are as follows: length, 2.77 mm.; greatest width, .51 mm.; length of cap, .48 mm.; width of cap, .42 mm.

Nymph.— First instar: Color white. Markings of head and thorax as in following stage. Antennæ entirely white; occasionally with a dark spot on the inner edge of the first segment. Hind femora with a few black spots near distal end; hind tibiæ with a conspicuous black space at distal end covering about one-sixth of entire length. Length 3 to 3.3 mm. Antennæ 8 mm.

Second instar: Color greenish white. Head with a short black line above and back of each eye, and with black specks at the base of minute bristles between eyes and antennæ. Thorax with a pair of dark lines near the median line. First segment of antenna with a black spot on the inner edge. Distal half of antenna very faintly annulated. Hind femur with only four or five black spots on the outer side near the distal end. Length 4.5 to 5 mm.

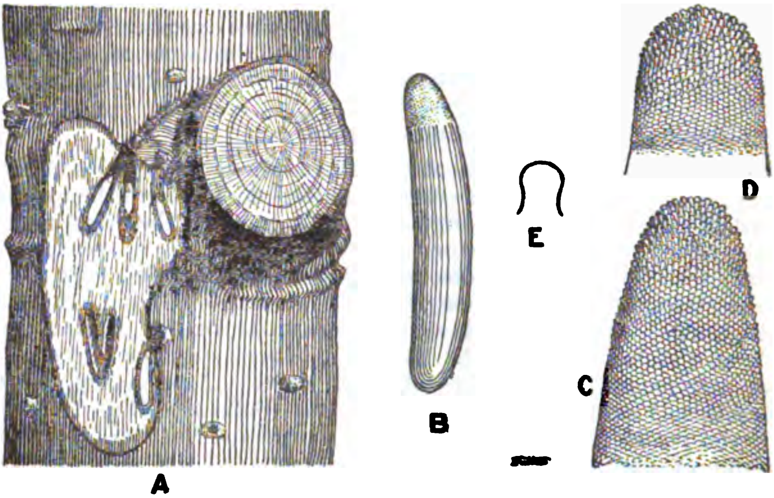

FIG. 32.— *Œcanthus angustipennis* FITCH.

a, Egg punctures in apple wood (x 3); b, egg (x 15); c, d, long and short egg caps (x 50); e, projection of egg cap (x 500).

Third instar: Dorsal area of abdomen pale green with a small median white spot on hind margin and a pair of white spots near front margin. Sides pure white. Basal antennal segment with the black spot on inner edge; and most specimens have a more or less distinct short line on the front side near the inner edge. Second segment with a small black spot on the front and inner side. Length 6 to 7 mm.

Fourth instar: Pale green. Head slightly yellowish above. Two median longitudinal lines of pronotum faint. Median area of abdominal segments pale yellowish green; the three white spots are relatively small. Upper part of side of each segment with a large elongate white spot reaching from front to hind margin, constricted or divided in the middle and surrounded by a ground color of pale yellow. Sides below are pure white. Antenna with a rather prominent white lump on the front and inner side and bounded on the outer side by a curved black mark. Second segment with an elongate spot. Length, 8 to 10 mm.

Fifth instar (Plate XXXII, Fig. a): Top of head between eyes yellow or pale orange. Median area of pronotum greenish; with two faint dark median lines. Abdominal markings as in the fourth instar. White prominence on the first antennal segment, with a black J-shaped mark; and the second segment with an elongate spot. Hind femora with a few black spots near the extremity. Length 11 to 12 mm.

Adult (Plate XXXIV, Fig. c).— Very slender. Pronotum a little longer than greatest breadth. Color very pale green. Light specimens have the top of the head between the eyes and antennæ yellow, and have a faint gray longitudinal streak on the pronotum. Darker specimens have the top of head orange yellow or even burnt sienna and the streak on the pronotum is strong brownish gray. Wings transparent, with greenish tinge and greenish veins. Fore wings of male comparatively narrow. Antennæ faintly annulated with gray on the distal part. The first segment is yellowish with the exception of a white prominence on the front and inner side, which bears a black J-shaped mark, with the crook turned inward. (Fig. 18, b.) Length to end of abdomen 14 mm. Fore wing of male 10–12 mm. x 4–5 mm. Fore wing of female 12 mm.

SONG.

The song of this species is not so loud as that made by *niveus* and is of a more mournful quality. The pitch is about a half tone higher and ranges from C♯ to D♯, two octaves above middle C, depending on temperature and somewhat on individual variation. Like the song of *niveus* it is intermittent, but can be readily distinguished by its longer notes and rests and its non-rhythmical character. Each trill continues from one to five seconds, but most commonly it lasts for about two seconds. The periods of rest vary more and may be from one to eight seconds or longer. The total number of notes per minute varies, even from one minute to the next, and is generally not more than ten, but may occasionally run as high as fifteen. On one occasion a specimen alone in a cage was observed to trill continuously for a minute or more. Out of doors the song might be unnoticed by anyone not endeavoring to detect it. On trees where *angustipennis* occurs in equal abundance with *niveus*, its song is nearly drowned out by the synchronous beat of the latter species and only by listening intently can it be detected. So far as observed it sings throughout the night and remains silent during the day.

OVIPOSITION.

In trees where *niveus* deposits eggs in branches from one to three inches in diameter, the female *angustipennis* usually selects for this purpose a small branch of about a half or third of an inch in diameter. She generally drills into the thick wrinkled places in the bark where the small twigs branch. Although we have only collected the eggs from apple, it is probable that they occur in all plants on which the adults are known to exist. This species has not been observed to use a drop of excrement for plugging up the opening of the egg puncture. For this purpose she snips off little particles of bark here and there, chews them up and pushes them into the hole. Occasionally when the female has deposited an egg, she does not completely remove the ovipositor, but starts to drill again in a slightly different direction and places another egg near the first. When cut into, the two punctures appear in the form of a V (Fig. 15, a). After an examination of a large number of egg punctures in apple orchards near Geneva only a few paired eggs were found, and caged crickets from this section deposited very few eggs in this manner. Apple branches from West Virginia and Kentucky contained a large number of the double punctures as well as single ones, and live specimens from Kentucky deposited fully half their eggs in pairs. The crickets of the two localities appear to be identical in every respect and this difference in habit seems to be merely a physiological variation.

ŒCANTHUS EXCLAMATIONIS Davis.

HISTORICAL NOTES AND DISTRIBUTION.

This species was first described by Davis (38) from specimens collected at Staten Island and several localities in New Jersey. It has since been recorded by Engelhardt from Johnson City, Tenn., and by Walden from New Haven, Conn. Mr. C. L. Metcalf writes that the North Carolina Department of Agriculture has a record of its occurrence in the western part of the state. The author has examined specimens taken by H. H. Knight at Hollister, Missouri, and by W. J. Kostir at Cedar Point, Sandusky, Ohio, and has collected the species with Mr. Davis at Central Park, Long Island, where it is fairly common.

HABITAT.

The only locality in which the author has any knowledge of the natural habitat of the species is at the edge of an area of natural prairie land on Long Island, northwest of the village of Central Park. In the zone separating the pine barrens from the open prairie the trees are scattered, and the predominant species are black jack oak (*Quercus marilandica*) and bur oak (*Q. macrocarpa*). *Exclamationis* was found in much greater numbers on the latter oak and in company with *angustipennis*. It was not collected from any other plants in this locality although many other trees were beaten and the weeds and grass were swept with a net.

DESCRIPTION OF LIFE STAGES.

Egg (Fig. 33, d).— The color is dull white, semitransparent and often yellowish when first laid. The cap (Fig. 33, b) is white but sometimes stained reddish from the bark. It is generally a little broader than long and the sides are parallel at base only and the tip is not so broadly rounded as that of *niveus*. The cap bears no spicules but is covered with low rounded elevations which in aggregate appear like scales. Those projections are about .02 mm. in diameter and .005 mm. high (Fig. 33, c).

The average measurements of twenty eggs are as follows: length 2.85 mm.; greatest width, .56 mm.; length of cap, .46 mm.; width of cap, .49 mm.

No specimens were obtained earlier than August 12 and at that time all had matured so that the nymphal stages could not be described.

Adult.— (Plate XXXIV, fig. b). Color nearly pure white, with a slight tinge of greenish yellow in places. Top of head between eyes and antennæ pale to medium yellow. Wings with yellowish veins. Antennæ pale, without gray annulations. First segment of antenna with a white opaque prominence on the front and inner side, which bears a black club-shaped mark. Second segment with a shorter black dash directly above; the two marks appear like an inverted exclamation point. The hind pair of wings are generally long and equal the cerci. Length to end of abdomen 14–15 mm. Fore wing of male 13–14 mm. x 5–5.5 mm. Fore wing of female 13–14 mm.

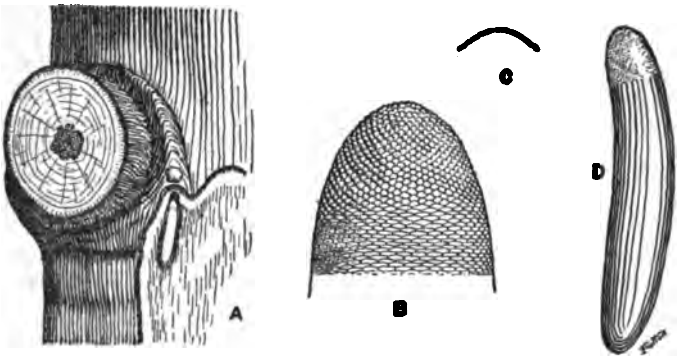

FIG. 33.— *Œcanthus exclamationis* DAVIS.
a, Egg in oak (x 3); b, egg cap (x 50); c, projection of egg cap (x 500); d, egg (x 15).

SONG.

The song of *exclamationis* is intermittent and non-rhythmical and most resembles the song of *angustipennis*. The pitch is the lowest of any of the species studied, and reaches only to the second B above middle C. The common length of note and rest is two or three seconds but this varies much, as in the song of *angustipennis*. The beginning of each note is comparatively weak, but the sound increases in volume and slightly in pitch and continues uniformly until it abruptly ends. In quality it most resembles the distant singing of the common toad.

It was observed that the males in the cages kept moving about while singing and that if no females were near they lowered their wings to the normal position between each note. If a female was close by, the male became more excited, kept the wings elevated and repeated the notes in more rapid succession.

OVIPOSITION.

No bur oak (*Q. macrocarpa*) could be obtained near Geneva, so that the females of this tree cricket were not supplied with the wood in which they would naturally oviposit. However they deposited many eggs in branches of red oak which were left in the cages. Whether the bark of the latter oak is more resistant than bur oak was not determined, but it seemed to require considerable labor for the females to bore the holes, and the whole process of egg laying generally continued for about an hour. In some cases the cricket seemed to be unable to finish the hole and would pull out the ovipositor and chew a pit in some other part of the branch for a fresh start. In the few cases of oviposition observed in detail the female would fasten a drop of excrement to the bark before depositing the egg and after pulling out the ovipositor would pick the pellet up and force it into the hole. She would then chew off small pieces of bark and add them to the plug, and spend five or ten minutes putting on the finishing touches. Although oak branches of various sizes were placed in the cages, the females mostly chose branches between half an inch and an inch in diameter and deposited most of their eggs in the thick bark about the base of side branches (Fig. 33, a).

ŒCANTHUS QUADRIPUNCTATUS Beutenmüller.

HISTORICAL NOTES.

For many years this light colored species had been regarded as merely a pale variety of *nigricornis*. Beutenmüller(17) in 1894 named it as a new species, his claim being that of the many pairs of tree crickets he had observed mating in the field, in no case were these two forms together. Many entomologists today believe that they are only varieties, and there can be no doubt about their close relationship, but careful studies on the two forms have revealed constant differences in habits as well as in body characters, which would indicate that they are quite distinct species.

DISTRIBUTION.

Quadripunctatus is a common species in most parts of New York State, with the exception of the northern forested areas. Localities in North America have been recorded as follows: Massachusetts (Faxon), Connecticut (Walden), Long Island and New Jersey (Davis), Ontario (Walker), Indiana (Blatchley), Illinois (Forbes), Minnesota (Lugger), Manitoba (Walker), Maryland (Rehn), Georgia (Allard), Kansas and Texas (Tucker), Texas and Colorado (Caudell). From specimens examined it can be recorded from the following states: Massachusetts, Connecticut, New Jersey, North Carolina and Florida (Amer. Mus.), Ohio (Kostir), Minnesota (Patch), Colorado and Utah (Titus) and Arizona (Morrill).

HABITAT.

Although *quadripunctatus* can sometimes be found in the same locality with *nigricornis* the preferred habitat and places of maximum abundance of the two species are quite different in character. Upland fields abounding in medium sized weeds such as aster, sweet clover, daisy, golden rod, ragweed, and especially the wild carrot or Queen Ann's lace (*Daucus carota*), form the favorite environment of this species. Quite often in a field of this character where *quadripunctatus* is prevalent, the brushy fence rows surrounding the area will be inhabited by *nigricornis*.

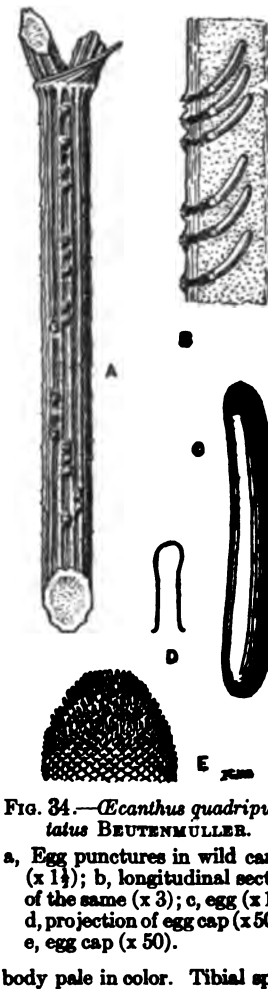

FIG. 34.—*Œcanthus quadripunctatus* BEUTENMÜLLER.

a, Egg punctures in wild carrot (x 1½); b, longitudinal section of the same (x 3); c, egg (x 15); d, projection of egg cap (x 500); e, egg cap (x 50).

DESCRIPTION OF LIFE STAGES.

Egg (Fig. 34, c).— The color when the eggs are first laid is bright golden yellow but becomes somewhat paler as development goes on. In general they are a trifle yellower than the eggs of *nigricornis*. The eggs average smaller than those of the other species; they are about equal in length to those of *angustipennis* but are more slender. The cap is pure white and comparatively small (Fig. 34 e). In shape it is hemispherical but a little more prolonged than the cap of *nigricornis* eggs. The projections of the cap are long and slightly thickened at the end (Fig. 34 d). Those near the end of cap measure .02 to .025 mm. in length, by .007 to .009 mm. in diameter. Measurements of fifty specimens of eggs average as follows: length, 2.8 mm.; greatest width, .45 mm.; length of cap, .30 mm.; width of cap, .35 mm.

Nymph.— First instar: Color, pale slightly greenish yellow. A slight infuscation extends along the dorsal side from the antennæ back, and is divided along entire length by a narrow pale median line. Just back of the antennæ the median line meets a pale transverse curved line which arches posteriorly. On the abdomen the shaded area is bounded on each de by a pale line which is in turn bordered by a nt dark line. The antennæ are gray all over but rkest toward the extremity. Length 3 mm. Annæ 6 to 6.8 mm.

cond instar: Pale greenish yellow with scatd whitish flakes. Pale dorsal median line present, l infuscation very faint. The two basal antengments are pale in color and the first segment a dark longitudinal streak on the inner edge front side. Length 4 to 5 mm.

d instar: Greenish yellow, mottled with small n spots and with a pale median line. Markbasal antennal segments of the same pattern dult but faint. Length 6 to 7 mm.

h instar: Greenish yellow. Most of hairs on body pale in color. Tibial spurs tip only. Last two segments of hind tarsi nearly black. Length 8.5 to 10 mm.

instar (Plate XXXII, Fig. d): Greenish yellow. Body hairs mostly pale. pots at bases of hairs on legs, cerci, top of head and median area of pronotum. on basal segments of antennæ more distinct. Length 11 to 12 mm.

Plate XXXIV, Fig. d).— Body pale yellowish green. Head more yellowish streaked with green. Abdomen yellowish above and below and greenish

on sides. *Ventral area not darkened.* Legs dull yellowish green. Antennæ pale yellow at base, outer segments shaded with dull brownish gray which grows darker toward tip. The basal antennal segment is flattened transversely and along the inner edge of the front face is a narrow black line and at the distal end near the middle of the segment is a black spot. The second segment has a pair of black spots on the front side. Forewings of the male are transparent, with greenish yellow veins. Forewings of female with numerous green veins. Ovipositor brownish with black tip. Length to end of abdomen, 12–14 mm. Forewing of male, 11 by 4.5 mm. Forewing of female, 10–12 mm.

SONG.

The crickets of this species are more diurnal in their habits than those heretofore discussed, and they can often be heard singing at midday. Late in the afternoon more individuals join the chorus and they continue to sing throughout the night. The sound is a continuous, shrill whistle with a pitch about the third F ♯ above middle C. It most resembles a small tin whistle but with a slight rasping or quavering quality. The call continues generally for a period of several minutes without ceasing, and in a field where large numbers are present it gives rise to a shrill, diffused ringing from which the individual sounds can not be distinguished. On cold nights the pitch drops a little and the sound becomes very faint. The call of old males often becomes a weak rasping shuffle. The continuous note distinguishes the song of this species and those following from that of the three preceding species, which have an intermittent call.

OVIPOSITION.

For the purpose of oviposition the female *quadripunctatus* selects small pithy weeds. She nearly always stands head downward on the stalk while depositing the eggs, which consequently are directed upward from the opening (Fig. 34, b). Out of a hundred eggs examined to determine this point only a short row of four were directed downward. The slant of the egg in the pith depends somewhat on the diameter of the stalk. The cap end lies within one-half to one millimeter from the opening and the inner end generally touches the wood on the opposite side if the stalk is not too wide. When the pith is of large diameter the eggs lie at about an angle of forty-five degrees with the long axis of the stalk, but if the pith is narrower the eggs lie more nearly parallel to the stalk, and in some cases the pith cavity is completely filled by the egg. The female works on the upper side of a leaning stem and deposits several eggs in a row. If the stalk happens to be vertical, as it seldom is, the eggs may be thrust in from different directions. The rows do not have the compactness and regularity to be observed in the oviposition of *nigricornis*, but are crooked and broken up into isolated punctures and short rows of from two to five punctures, each group separated by gaps from three to fifteen millimeters long (Fig. 34, a). Within the short rows the holes are placed about one to each millimeter, and seldom more than eight or ten are found in one group. In some cases the eggs are so scattered along the stem that they can scarcely be said to form a row. After the egg is deposited the female chews off a small patch of the outer tissue of the stalk and pushes the material into the hole at the same time pressing in the frayed edges. The neatly capped puncture is a very inconspicuous object. In the choice of plants for oviposition this species is very partial to the wild carrot (*Daucus carota*). So confined are they to this plant, at least in this region, that after many long searches only two other plants were found bearing their eggs. One of these was a small plant of golden rod and the other a purple aster. Doubtless other small plants with a solid pith are used in localities where the wild carrot is not so abundant. The size of stalk used varies from two to five millimeters in diameter and in this respect the insect shows a marked difference from the closely related *nigricornis*.

ŒCANTHUS NIGRICORNIS Walker.

HISTORICAL NOTES.

This insect is very generally known in literature under the name *Œ. fasciatus* (De Geer), Fitch, since it was first described by Fitch under that name. It has however been pointed out by Scudder(5) and later by Beutenmüller(17) that Fitch erroneously identified his insect as De Geer's(1) *Gryllus fasciatus* which is really a *Nemobius*. Therefore he did not give a name to his species and Beutenmüller recommended that the name *nigricornis* be used instead. The original description of the latter by Walker(8) in 1869, fits this insect very well and is undoubtedly taken from the same species. As stated before Walsh(6) and Riley(7, 10) considered this species as a dark variety of *niveus* and many collectors at the present time consider this tree cricket and *quadripunctatus* as varieties of the same species.

DISTRIBUTION.

This tree cricket is very common and is widely distributed over New York and throughout the United States. From literature it is recorded as follows: Massachusetts (Faxon), Connecticut (Walden), New Hampshire (Henshaw), New Jersey (Davis), Ontario (Walker), Tennessee (Morgan), Mississippi (Ashmead), Michigan (Allis), Indiana (Blatchley), Illinois (Forbes), Minnesota (Lugger), Nebraska (Bruner), Oklahoma and Arizona (Caudell), Texas and Kansas (Tucker), California (Baker). From specimens examined we can record it from the following states: New Jersey and Connecticut (Amer. Mus.), North Carolina (C. L. Metcalf), Ohio (Kostir).

HABITAT.

In general *nigricornis* prefers larger plants and more dense growth than *quadripunctatus*, and its habitat is more varied. While the latter is confined largely to upland weedy fields, the former can be found in tall, rank growths of weeds such as in swamps and river bottoms, in brush or second growth, in fence rows grown up with bushes, briars and vines, in raspberry plantings, vineyards, nurseries and even occasionally in orchards. While the list of plants used for oviposition, given in a following paragraph, contains many names of trees, it has been our experience that these records are of rare or local occurrence and generally refer to small seedling trees growing among brush, and thus do not convey the proper impression regarding the habitat of the insect.

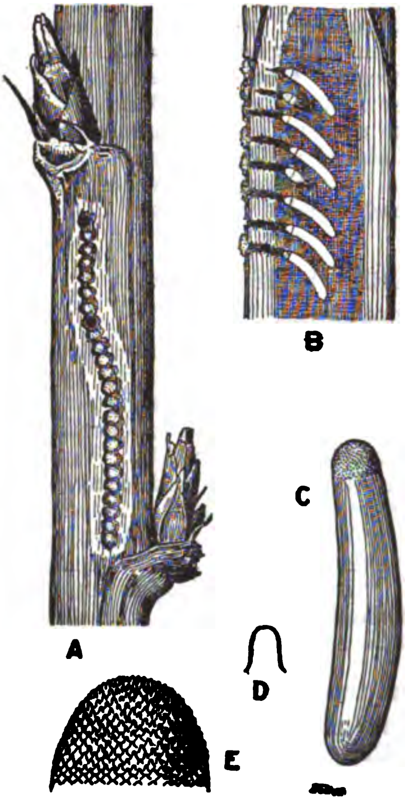

FIG. 35.— *Œcanthus nigricornis* WALKER. a, Egg punctures in raspberry (x 1½); b, longitudinal section of the same (x 3); c, egg (x 15); d, projection of egg cap (x 500); e, egg cap (x 50).

DESCRIPTION OF LIFE STAGES.

Egg.— The eggs (Fig. 35, c) are of a light or medium yellow color, and brightest when first laid. The cap is rather small, broader than long and hemispherical, the sides being parallel only at the extreme base. (Fig. 35, e.) The color of the cap is dull white but is sometimes stained reddish when in certain plants. The projections are short, cylindrical and rounded at the tips. (Fig. 35, d.) Those near the end of the cap are .012 mm. long by .008 mm. in diameter. The eggs of this species can be distinguished from those of *quadripunctatus* by the much shorter projections on the cap. Average measurements of thirty-six specimens are as follows: Length 2.9 mm.; greatest width .57 mm.; length of cap .33 mm.; width of cap .44 mm.

Nymph.— First and second instars: In these two stages the crickets seem to be identical in every respect with those of *quadripunctatus*.

Third and fourth instars: The differences between *nigricornis* and *quadripunctatus* in these two stages are very slight and only relative. The former is more nearly pure green with less yellowish tinge; dorsal infuscation is usually plainly visible; hind legs, especially the tibiæ, more heavily speckled with black dots; and the black line on the basal antennal segment is broader. These statements are based on averages only. Not knowing where any given specimen was found it would be impossible to state with certainty which species it belonged to.

Fifth instar (Plate XXXII, Fig. c): This is the only nymphal stage in which the two species can be separated. *Nigricornis* averages a little larger, and is not so yellowish in color. Dorsal part of head is slightly brownish. Hairs of body are mostly black or brown instead of pale. The legs appear dark, due to dark hairs and spots. Spurs are black nearly to base. Antennæ are black or nearly so in outer part; the four spots at the base are large and conspicuous. The most constant character, which can not be relied on in dried specimens, is the dark band on the ventral side of the abdomen; the sternum of each segment is slightly infuscated and covered with small brownish spots.

Adult (Plate XXXIII, Fig. c).— The amount of color in this species varies considerably and newly moulted specimens are lighter than old ones. The light specimens are greenish yellow. Head with blackish or sepia shading on median area, sides and front below the antennæ. Pronotum with similar shading on sides and median area. Wings clear with greenish yellow veins and tinge of green between veins on inner edge. Femora dull green; tibiæ and tarsi black. Antennæ black; first and second segments greenish yellow. The first segment has a brownish shading covering the inner and upper part of the front side, and including a heavy black line along the inner edge and a black spot near the distal end, which may be confluent with the black line. Second segment with two elongate black spots. (Fig. 18, f.) *Venter of abdomen solid black;* the remainder greenish yellow. Dark specimens late in the season have the head, pronotum, legs and antennæ nearly entirely black. Both pairs of spots on the two basal antennal segments are confluent (Fig. 18, g) and in some specimens both of these segments are almost entirely black. Length of body, 14 mm. Fore wing of male, 10-11 mm. by 4.5 to 5 mm. Fore wing of female 11-12 mm.

SONG.

The song of *nigricornis* so closely resembles that of *quadripunctatus* that it is very difficult to distinguish the two. On the average the song of the former is louder and shriller and with less rasping quality. The pitch of the two is the same, the third F ♯ above middle C, and both species have the habit of singing during the day as well as at night. After a study of the habitats of the two species, however, one can judge fairly accurately in the field, which species he hears from the character of the surrounding vegetation.

OVIPOSITION.

In preparing for oviposition the female generally selects a position well above the ground. She works head uppermost, and if the stalk of the plant leans a little she prefers to operate from upper side. As with other tree crickets the first step in the process is to chew a pit in the bark to start the ovipositor. The length of the drilling operation depends on whether the eggs are being deposited in the stalk of an herbaceous weed or in the hard woody twig of a tree or bush and varies from ten minutes to half an hour. After the egg has been deposited and the mucilaginous substance discharged into the hole, the female removes the ovipositor and chews off pieces of the bark just above the puncture to plug up the opening. The pit made in so doing serves as a starting point for the next drilling operation. This is repeated a number of times and results in a long compact row of eggs, with from seven to ten punctures to each centimeter. (Fig. 35, a.)

The eggs slant across the pith cavity at an angle of from forty-five to sixty degrees with the long axis of the stalk. (Fig. 35, b.)

If the pith cavity is small and the woody layer thick, a part of the capped end of the egg is partly imbedded in the wood. When the punctures are close together the eggs are directed alternately to the right and left so that they do not interfere with each other. In contrast to the oviposition of *quadripunctatus* the eggs of this species are generally directed downward from the opening as the result of the female working head uppermost. In localities where strong prevailing winds have caused all the weeds to lean in one direction, the habit of the female in ovipositing on the upper side of the stalk might give rise to the impression that she always worked on the same side with reference to the points of the compass.

The oviposition period commences during the latter part of August and generally extends through the month of September. The total number of eggs deposited varies greatly with individual crickets. In 1910 the records of six pairs confined in breeding cages were respectively as follows: (1) 165 eggs, (2) 64, (3) 26, (4) 78, (5) 52, (6) 31. During 1913 three pairs deposited respectively 22, 51 and 60 eggs. The eggs were deposited in rows of from seven to twenty-one punctures. Occasionally the number of eggs in a series was increased over night or over a succession of nights at varying intervals by ovipositions by the same female. Observations in a patch of raspberries showed that the number of eggs in a row ranged from two to eighty-seven. The average number in nineteen rows taken at random was about thirty-two eggs.

This species prefers for the reception of its eggs plants which have a central pith surrounded by a woody outer layer, and there are a great many plants of this character which are selected by the insect for this purpose. Eggs are deposited most abundantly in raspberry, blackberry, *Erigeron canadensis* and the larger species of *Solidago*. They are also common locally in elder, grape, sumac and willow. A few eggs may occasionally be found in the twigs of peach [1] apple,[2] elm, maple and hickory. Mr. Goodwin of the Ohio Station writes that considerable oviposition by this species occurs in peach orchards and vineyards in northern Ohio, especially on trees and vines which adjoin uncultivated fields. Similar conditions with respect to vineyards have been noted in the grape-growing region in Chautauqua county, New York. Mr. W. T. Davis of Staten Island reports that he has also found eggs of this insect in wild cherry, white ash and *Baptisia tinctoria*. In going over the literature of this species we have found numerous descriptions of the work of this insect in various plants besides those given above, but always under the name of *niveus*. When the eggs are described as deposited in long rows there is little doubt as to their identity; for the only other widely distributed species with this habit is *Œ. quadripunctatus*, which deposits eggs only in smaller and more delicate plants. On this assumption additional host plants as recorded in literature are currant, Helianthus, artichoke, Ambrosia, plum, cottonwood, box elder, cherry, dogwood, black locust, honey locust, sycamore and catalpa.

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[1] From material collected by J. L. King at Gypsum, Ohio.

[2] From material collected by B. G. Pratt, New York City.

In the size of the stalk selected for oviposition *nigricornis* shows a distinct difference in habit from *quadripunctatus*, in that it almost always seeks one of larger diameter. With grape vines and certain weeds, stems less than five millimeters in diameter are seldom chosen and with raspberry canes and elder the common thickness of the wood is not much under a centimeter.

ŒCANTHUS PINI Beutenmüller.

HISTORICAL NOTES AND DISTRIBUTION.

This tree cricket was first described by Beutenmüller(19) from specimens collected in Windham Co., Conn. It has since been recorded as follows: Gloucester, Mass. (Henshaw); Riverton, N. J. (Rehn); Karner, N. Y. (Felt); Staten Island and Long Island, N. Y., and Bloomsburg, Columbia Co., Pa. (Davis).

HABITAT.

All the above records are from specimens collected on pine trees and apparently this species does not inhabit any other kind of plant. The author in company with Mr. Wm. F. Davis collected a large number of specimens near Central Park, Long Island. In this region as also in the New Jersey pine barrens the pitch pine (*Pinus rigida*) is the predominant species. The trees are rather scattered and closely surrounded by scrub oak and other smaller plants, but in no case were specimens taken on anything but the pines. Mr. Davis informs me that his specimens collected at Bloomsburg, Pa., were taken from the Jersey or scrub pine (*P. virginiana*).

DESCRIPTION OF LIFE STAGES.

Egg.— The eggs (Fig. 36, d) closely resemble those of *nigricornis*. The color is yellow but not so bright as the eggs of *quadripunctatus*. The cap (Fig. 36, e) is a trifle larger than that of *nigricornis* and the projections (Fig. 36, c) are a little larger and flattened, except those on the extreme tip which appear to be cylindrical. The shape of the projections is the most prominent difference between the eggs of the two species. This is most easily seen when the cap end of the egg is raised so that one gets an end view of the projections on the side. Those of *pini* appear transversely elliptical, with one diameter about double the other, while those of *nigricornis* appear round or broadly oval. The projections of the eggs of *pini* measure .018 mm. long, .012 mm. wide and .006 mm. thick. The average measurements of twenty eggs are as follows: Length 3.14 mm.; greatest width .55 mm.; length of cap .35 mm.; width of cap at base .47 mm.

Nymph.— Fifth instar: (Plate XXXV, fig. a.) Specimens were not obtained of any stage earlier than the fifth nymphal instar, which is as follows: Pronotum short and broad. Head and thorax light brown, with obscure pale median line and somewhat paler on edge of disk of pronotum. Wing pads green, with dark green veins. Abdomen with a broad dorsal area of dull green, bounded by a streak of pale yellowish green on each side. Sides of abdomen dull green, fading out below. Sides and under part of thorax slightly pinkish. Antennæ yellowish on first two segments, remainder brown, growing darker toward tip; basal segments with black markings resembling *quadripunctatus*. Legs greenish brown; spines on hind tibiæ black. Length 14.5 mm.

Adult.— (Plate XXXV, fig. a.) Head and pronotum nearly uniform dull reddish brown; pronotum with a paler stripe on each side. Underside of thorax pale yellow with brown blotches. Abdomen with ventral area uniform dull brown, bordered on each side by a narrow, sharply defined cream colored stripe; sides dull brown; dorsal area greenish brown. Antennæ dull brown; two basal segments pale brown with black markings on the front side; first with a black line along inner edge and a transverse, slightly oblique line near the end; second with two elongate parallel black spots. (Fig. 18, e.) Legs dull, olive brown. Wings of male transparent, with green veins; area anterior to the rasp clouded with green; a stripe on the inner edge, beyond the rasp and one along the fold of the wing, solid yellowish green, so that when wing is raised it is seen to be clear, with two green stripes. Wings of female with bright green veins except along the fold where they are pale yellow, giving the effect of a cream colored stripe. Near the base they are tinged with reddish brown. Ovipositor dark brown with black tip. Length of body 15–16 mm. Fore wing of male 13 mm. by 5 mm. Fore wing of female 12 mm.

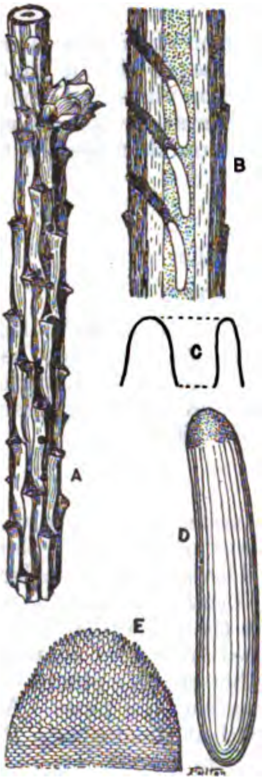

FIG. 36.— *Œcanthus pini* BEUTENMÜLLER.

a, Egg punctures in pine (x 1½); b, longitudinal section of the same (x 3); c, projection of egg cap, two views of the same structure (x 500); d, egg (x 15); e, egg cap (x 50).

SONG.

The song of *pini* is a shrill, continuous whistle, which closely resembles the call of *nigricornis* and *quadripunctatus*, but can be distinguished by its lower pitch. It is on the average about a note and a half lower than the song of those species, or the third E above middle C. Beutenmüller(15) describes the sound when many individuals are singing together, as " not unlike the jingling of sleigh-bells at a distance." The crickets in the cages in the laboratory generally began singing late in the afternoon and continued throughout the night.

OVIPOSITION.

The females in our breeding cages oviposited mostly at night but on a few occasions they were observed drilling in the daytime, both in the morning and afternoon. Before beginning to drill a pit is chewed in the bark as with the other species. The pine twigs are rather resistant and the drilling operation requires thirty or forty minutes. On completion of the process the hole is plugged up with bits of chewed bark. One female under observation deposited fourteen eggs in a single night; another, which was caged alone with a male, laid only thirty-one eggs in all. The eggs are placed in rows like those of *nigricornis* but are not so close together; one puncture to every three millimeters is a common distance. A favorite point for oviposition is at the end of one of the elongate scales of bark with which the pine twigs are covered. (Fig. 36, a.) The eggs may slant in either direction in the twigs but of the limited number deposited in the laboratory most of them were directed downward indicating that the females preferred to work head uppermost.

In the breeding cages the crickets were first supplied with white pine and Austrian pine, but later some branches of the pitch pine were procured. Some apple twigs and wild carrot stalks were also placed in the cages. The crickets showed a decided preference for pitch pine while it was in fresh condition but later oviposited in the wild carrot stalks and apple twigs. This was probably because the pine twigs became dry and hard and a fresh supply could not be readily obtained. In no case did the crickets oviposit in the other two species of pine. The size of the pine twigs used varied from three millimeters to nearly a centimeter in diameter. Eggs in the narrow twigs were found to lie in the small pith cavity while those in the larger branches were partly or wholly imbedded in the wood.

ŒCANTHUS LATIPENNIS Riley.

HISTORICAL NOTES AND DISTRIBUTION.

Riley's(10) original description of this insect is accompanied by a brief but correct account of the song and egg laying habits. He had described the eggs in grape in an earlier report(9) but at that time supposed they were the eggs of *Orocharis saltator*. His specimens were mostly from Missouri, but he had one from Alabama and one from South Texas. Other records obtained from literature, correspondence and collections are as follows: Long Island and New Jersey (Davis); Michigan (Allis); Ohio (author's collection); Indiana (Blatchley); Illinois (Forbes); Minnesota (Dugger); Nebraska (Bruner); North Carolina (C. L. Metcalf); Kentucky (Schoene); Tennessee (Morgan); Georgia (Allard). The list given here would indicate that the range of this cricket does not extend as far north as that of the other widely distributed species. As far as we know it has been collected in this state only in the southeastern part.

HABITAT.

The author is more familiar with the species in southern Ohio, where eggs were obtained for life history studies. There the insect is common in weedy places, in flower beds and shrubberies about farm houses, and especially among grape vines. W. T. Davis writes that in Long Island, Staten Island and New Jersey he has found *latipennis* fairly common among the oak scrub.

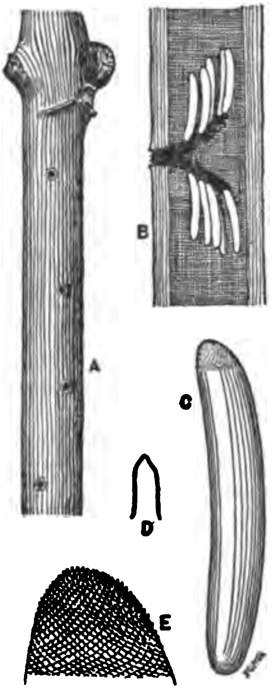

FIG. 37.— *Œcanthus latipennis* RILEY.

a, Egg punctures in grape (x 1½); b, longitudinal section showing eggs in golden rod (x 3); c, egg (x 15); d, projection of egg cap (x 500); e, egg cap (x 50).

DESCRIPTION OF LIFE STAGES.

Egg.— The eggs (Fig. 37, c) are rather long and slender, and of a pale yellow color. The cap (Fig. 37, e) is white but rather inconspicuous; it is broader than long and most resembles the cap of *nigricornis* but is generally a little oblique, that is, the extreme tip is nearer the side of the egg having the lesser curvature. The projections of the cap (Fig. 37, d) are narrow and a trifle longer than those of *nigricornis* and many are obtusely pointed at the tip rather than rounded. The long ones near the end of the cap measure .017 mm. long by .007 mm. in diameter. Measurements of thirteen specimens of eggs taken from several sets show considerable uniformity in shape and size. The averages are as follows: length 3.00 mm.; greatest width .50 mm.; length of cap .28 mm.; width of cap .40 mm.

Nymph.— First instar: Ground color of body pure white. A broad band of purplish red extends full length along the dorsal side and encloses a narrow white median line, which joins a transverse curved line between the eyes. On the concave anterior side of the latter white line is a small patch of red between the antennæ. Eyes are faintly yellow. Antennæ are unmarked. White median line on the abdomen is bordered on each side by a dark brown line of about the same width. Hind margin of each segment with a pair of conspicuous black bristles on the brown lines; all other hairs on abdomen pale and scarcely visible. Cerci with a few specks of red. Legs unmarked; last segment of hind tarsi dark. Length 3.5 mm.

Second instar: Ground color of body slightly yellowish, most pronounced along the sides. Reddish band consists of a pink ground color much mottled and speckled with red, darkest along the median white line and edges. White line widened into a spot on hind border of each abdominal segment. Reddish brown line on each side less well defined than in first instar. Hairs and bristles on red band dark in color. Antennæ white; segments in outer half very indistinct. Cerci pinkish at base. Last segment of hind tarsi black. Length 5 mm.

Third instar: Ground color pale yellow, strongest along sides. Median dorsal band of pale pink ground color, thickly speckled with reddish spots which occur at the bases of minute black bristles. Top of head posterior to and between the eyes marked with longitudinal reddish streaks. In thorax the pink blends into yellow on the sides but on the abdomen the pink area is outlined by a reddish line which is scalloped or curved toward the median line on the hind part of each segment. Narrow median pale line present, but obscure in places. Posterior edge of each abdominal segment with a white elevated spot on the median line, bounded on each side by smaller black spots, bearing tufts of black bristles. Antennæ pink at base, fading out into white on segments 4 to 6. Length 7 mm.

Fourth instar: General color pale greenish yellow. Outer ends of the transverse pale line between eyes, curl strongly forward. Median reddish band obscure on thorax. Abdomen yellowish green on sides with whitish blotches; upper part becomes uniform pale yellow and lower part cloudy white. Pinkish median band much modified on abdomen. Each segment bears a vase-shaped figure, broad and rounded on the anterior part, constricted just back of the middle and flaring out again on the hind margin. Ground color of figure pale pink, except in the enlarged part where it blends into a spot of pale greenish yellow in the center. Figure has a reddish margin and bears a number of minute dark bristles with a reddish spot at the base of each. Median line paler and slightly elevated; near the hind margin of each segment it is produced into a small white elevation at each of which is a bristly black spot. Length 10.5 mm.

Fifth instar: (Plate XXXIII, fig. b). Head light yellow; upper part from antennæ back dull pink; transverse and median pale lines as in earlier instars. Pronotum yellowish, strongest on sides; dull median band made up of small black hairs and brownish specks. Abdomen colored similar to preceding stage; ground color of vase-shape figures on segments very pale or even white. Basal segment of antennæ yellowish mottled with pink; following segments reddish but fading to white within four or five millimeters. Legs greenish, unmarked. Last segment of hind tarsi black. Length 12 to 13 mm.

Adult (Plate XXXV, fig. b).— Body whitish. Head and pronotum tinged with yellow. Top of head from antennæ back with a pink patch, occipital region with four longitudinal dusky streaks fading out in front. Pronotum with a median dusky band, darkest in front; this is plain in some specimens and absent in others. Antennnæ red at base, fading out near the eighth segment; the first segment has pale yellow ground color mottled with red especially along inner edge. Remainder of antennæ white faintly annulated at intervals with gray; extreme distal part dark gray. Legs white; knees yellowish; hind femur with a small black spot just before distal end. Wings of male transparent; in some specimens the large cells near the tip are bordered by slightly infuscated lines running near and parallel to the veins. Length of body 15–17 mm. Fore wing of male 13 to 16 mm. by 6.5 to 8. mm. Fore wing of female 13–14 mm.

SONG.

The song of *latipennis* is louder than that of any other tree cricket discussed in this bulletin. It is a clear, continuous whistle resembling the call of the preceding species, but is of a lower pitch, and has a more musical and bell-like quality. On an ordinary summer evening the tone is about the third D♯ above middle C, but on cool nights the pitch may drop a half-note lower. In southern Ohio where the author has observed this cricket in the field, the males began singing in full chorus at dusk and continued throughout the night. The reared specimens in breeding cages at Geneva were much more shy than the other species and would not begin to sing until dark and when all was quiet about the laboratory.

OVIPOSITION.

This insect deposits its eggs in a peculiar manner which seems to possess some advantages over the methods employed by other tree crickets. In depositing the first egg in any part of the stalk the process is essentially the same as that of the three preceding species except that the female seems to prefer working on the underside of a stalk and may start with head either up or down. After the egg is placed the female turns around and chews at the hole for several minutes but does not plug it up. She then inserts the ovipositor in the hole and begins to drill, this time in the opposite direction. Not having the hard woody layer to penetrate, this second drilling reams out a hole in the pith in about five minutes and a second egg is deposited. The insect then turns around, chews at the hole and starts to drill again in the original direction. This process is continued, the female turning around after each drilling until several eggs have been deposited on each side of the hole. (Fig. 20, b.) Apparently no attempt is made to plug up the opening, which, on account of the repeated drillings, is large and conspicuous.

The eggs of this cricket were collected in southern Ohio in grape vines and in large stalks of golden-rod growing near the vines. The parts of the plants most used were the young shoots of the vines, from three to five millimeters thick and the upper ends of the golden-rod stalks where they were about five millimeters in diameter. The holes were most often on the under side and in many cases were arranged in rows, with intervals of about one centimeter or a little more. (Fig. 37, a.) The eggs of each of the two groups lie side by side in the pith and about parallel to the long axis of the vine or stalk. The size of the pith determines the number of eggs that can be placed together. The grape vine has a small pith and will hold only two or three eggs on a side, while in the golden-rod as many as six can be found in a single cluster. Thus a single hole in the outer woody layer may serve for the deposition of from four to twelve eggs.

NEOXABEA BIPUNCTATA De Geer.

HISTORICAL NOTES.

It seems desirable to include in this bulletin an account of the single described species of *Neoxabea,* since it is so closely related to the crickets of the genus *Œcanthus* that it was for a long time considered as a species of the same genus. Riley(10) regarded the differences between this species and the other tree crickets of generic importance and included it in the same genus with *Xabea decora* Walker from Sumatra, to which it seemed more closely allied. Later Kirby(31) established it in a genus by itself under the name of *Neoxabea.*

DISTRIBUTION.

Judging from the meager records of the species in this state it appears to be confined to the southeastern corner. The collection of the American Museum contains specimens from the Ramapo

Mountains, Rockland County, and from Southampton, Long Island. Other records obtained from literature and collections are as follows: Connecticut (Walden); New Jersey (Smith); Pennsylvania (De Geer's type), Ohio (King), Indiana (Blatchley), Illinois (Forbes), Kansas (Tucker), North Carolina (Amer. Mus.), Georgia (Allard), Nicaragua (Baker). Apparently these records indicate that most of New York is too far north to be within the range of this insect.

DESCRIPTION OF LIFE STAGES.

Egg.—Very long and slender and of a pale, transparent yellowish color. The cap is indistinct and consists only of an opaque, minutely roughened portion of the egg, and bears no projections as is common in *Œcanthus* eggs. Near the base the roughness takes the form of shallow depressions arranged in spiral rows, but toward the tip the rows break up and the surface is rugulose. The eggs measure from 3.85 to 4.10 mm. in length and from .45 to .50 mm. in diameter.

Adult.— The generic characters are as follows: hind tibiæ without teeth or spurs except at tip; basal segment of antennæ with a blunt tooth on anterior side; maxillary palpi with third and fifth segments very long and fourth short; hind wings very long and protrude behind body like tails. The general color is pale pinkish brown. The fore wings of the female bear two large dark brown blotches, one in front of the other. Male wings unmarked. Legs pale pinkish color. Length of body about 16 mm. Fore wings 13 mm. Hind wings 20 mm.

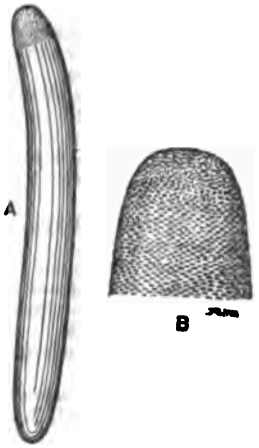

FIG. 38.— *Neoxabea bipunctata* DE GEER.
a, egg (x15); b, egg cap (x50).

HABITS.

Our knowledge of this insect is confined to observations on a few adult females collected at Cedar Point, Ohio, by J. L. King of the Ohio Experiment Station. The lack of males precluded any observations on the song of the insects but did not prevent the females from depositing eggs. Not knowing at the time the natural host plant of the species it was necessary to place in the cages a number of different kinds of plants, among which was an apple branch about half an inch in diameter. This was selected by the females for oviposition and the eggs were deposited in the bark in about the same manner as those of *niveus*, except that most of them were directed upward from the hole. The crickets seemed to adapt themselves quite readily to the apple, but at the place where they were collected no apple trees exist, and I have since been informed by the collector that the insects were found on oak, willow and wild grape vines at a height of five or ten feet. The trees were along the forest border or standing isolated at the edge of open, sandy areas.

ACKNOWLEDGMENTS.

The author wishes to express his obligations to numerous entomologists for cooperation in determining the distribution of the

insects. He is greatly indebted to Mr. W. T. Davis of Staten Island for information on the habits of the crickets and assistance in collecting on Long Island; to Mrs. L. L. Van Slyke of Geneva for notes on the musical qualities; and to Mr. J. L. King of the Ohio Experiment Station for furnishing living specimens of *Neoxabea bipunctata.*

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THE GRAPE ROOT-WORM.*

F. Z. HARTZELL.

The insect commonly known as the grape root-worm is not a true worm but is the larva of a beetle belonging to the family Chrysomelidæ. To this same family belong such well known species as the Colorado potato beetle and the cucumber beetle. This beetle is technically known as *Fidia viticida* Walsh, and is one of the most injurious insects that attacks grapes in New York State. It has occasioned much damage in the Chautauqua and Erie Grape Belt which extends from Erie, Penn., to near Buffalo, N. Y. In fact, the annual losses due to this pest have been, during years of greatest injury, not less than half a million dollars. However, in other grape sections of the State the grape root-worm is not known to growers generally because its injuries have never been prominent; but entomologists have found the insect as far east as Massachusetts and Connecticut, so it behooves all grape growers to become acquainted with this pest in order that, should the insect become numerous, control measures may be adopted before the vineyards have been ruined.

This circular gives in concise form the prominent facts of the life history and measures for repression so far as they are believed to have been established.

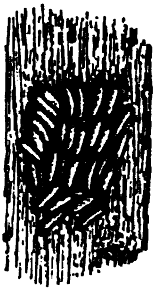

FIG. 39. — EGGS OF GRAPE ROOT-WORM. (Enlarged.)

LIFE HISTORY.

The eggs of the grape root-worm are very small (.04 inch in length) and are of a yellow color. Fig. 39 represents a batch of eggs enlarged. On the average, one hundred and seventy-five eggs are laid by each female during July and August and from them hatch tiny, lemon-yellow grubs which drop from the vines before feeding and burrow into the soil. The endurance of these small grubs is remarkable; for they possess strength sufficient to enable them to burrow through eighth or ten inches of compact soil until they find the roots of the vine where they feed. The tiny rootlets are first eaten and later the larger roots are attacked. When enough grubs are present they destroy all the rootlets and later eat channels into the large roots, even girdling them. *Vines showing roots with the bark channeled and an absence of small fibrous roots furnish almost conclusive evidence of the work of this pest, and to growers who are unacquainted with the*

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* A reprint of Circular No. 41, June 21, 1915.

insect, this root condition should be the first sign to be sought in a diagnosis of the cause of weakened vines. (Plate XXXVII, fig. 3.) Upon finding such a condition the grower should search the soil carefully for the grubs. (Fig. 40.)

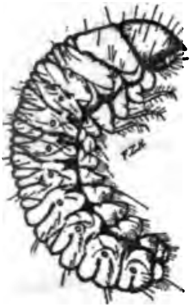

FIG. 40.— LARVA OF GRAPE ROOT-WORM (Much enlarged.)

The grubs feed from hatching (during August) until the latter part of October, if the weather remains mild, but towards the latter end of the month they will be found burrowing to a depth of ten to twenty-four inches where they work their bodies about in the soil and thus form cells in which they pass the winter. Most of the grubs have reached full growth by this time, although individuals are found which are not full grown.

During the month of May, these grubs, which have survived the rigors of the winter, leave their resting quarters and come nearer the surface and those which are not full grown again feed on the roots of the vine.

During the early days of June, the full grown larvae form cells from four inches to ten inches beneath the surface of the soil (the depth is influenced largely by moisture conditions, although there is individual variation in the same soil) and here from June 10 to 15 we find a large percentage of the grubs changing to pupae (Fig. 41). Grape growers locally call this the " turtle " stage. These pupae are about .3 inch in length and are cream colored except the developing wings and legs which are white.

The pupae are unable to form new cells if the original cells are broken, but they possess enough activity to move their bodies slightly in the broken cells.

It is almost needless to state that no feeding occurs in this stage, but very important changes are taking place within the body of the insect whereby it is being changed from a grub to a beetle. After a sojourn of from ten days to two weeks in the pupa cell that which was a grub appears as a light-colored beetle. (Fig. 42.)

Several days intervene between the transformation and the time the beetles burrow out of their cells and emerge into the light of day.

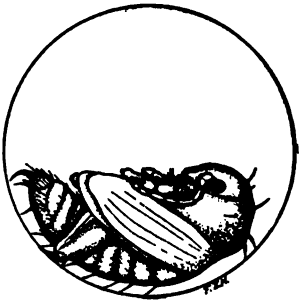

FIG. 41.—PUPA OF GRAPE ROOT-WORM. (Much enlarged.)

The yellowish-brown color of the chitin soon changes under the action of sunlight to a dark reddish-brown but this color is usually subdued by the presence of short gray hairs over the greater portion of the body, which causes the insect to have a grayish appearance. These beetles are about one-fourth of an inch in length and are not very active. They feed by tearing the upper tissues of the leaves with their mandibles producing peculiar chain-like markings (Plate I, Fig. 41) which are good evidence of the presence of the pest and also indicate the number of beetles present. Feeding usually takes place within a day of emergence and the appetites of the beetles are ravenous at first but later they do not feed so greedily. The date of emergence of the first individuals is normally between the 20th and 25th of June but in certain seasons they may appear as early as June 15 or as late as July 5.

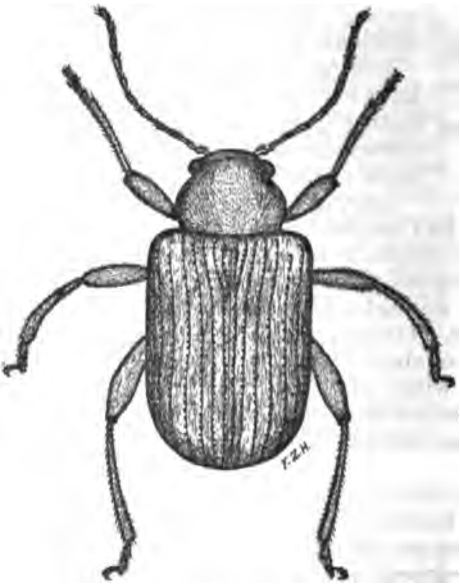

FIG. 42. — ADULT GRAPE ROOT-WORM.
(Much enlarged.)

Much of the insect's time is spent on canes of the vine, especially near the axils of shoots, and in such situations their color blends with that of the vine thus protecting them from their enemies. As a further protection these beetles drop to the ground and remain motionless for a minute or two upon the least jarring of the vine except when this is produced by the wind. While lying motionless upon the ground the color of their bodies blends so perfectly with the color of the soil that they are difficult to find. This habit of " playing possum " is an important protection to the species. After feeding for a period, usually not exceeding two weeks, the females begin to deposit their eggs under the rough bark of the canes and

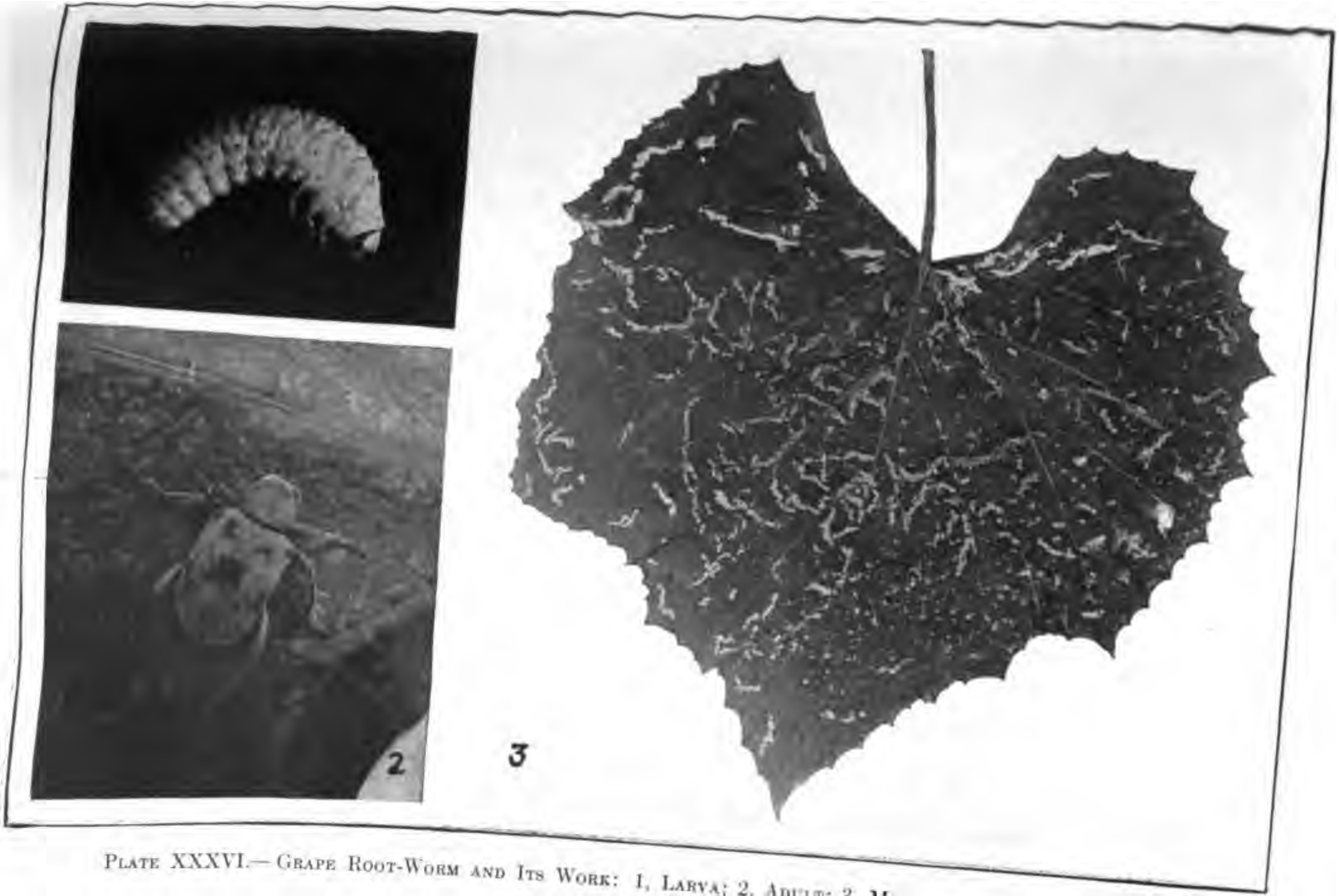

Plate XXXVI.—Grape Root-Worm and Its Work: 1, Larva; 2, Adult; 3, Marks of Feeding on Leaf.

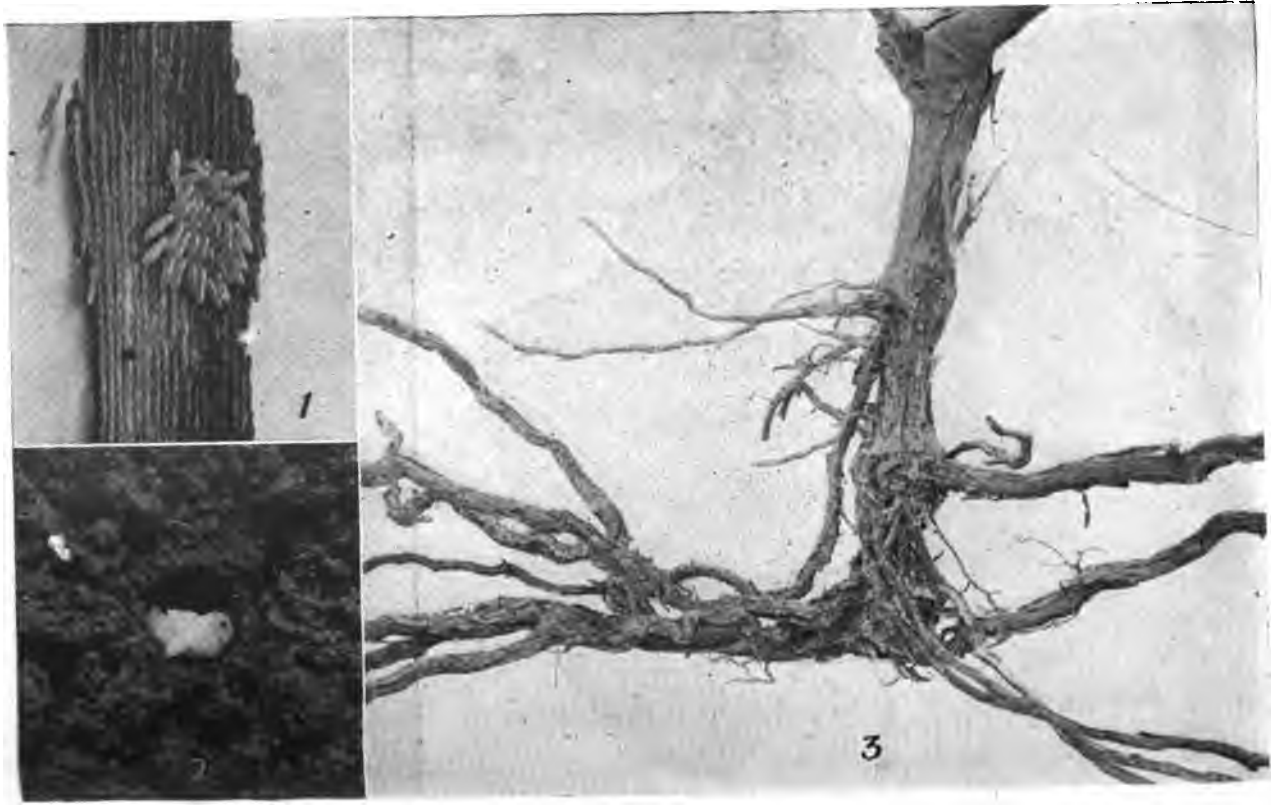

Plate XXXVII.— Grape Root-Worm and Its Work; 1, Eggs; 2, Pupa in Cell in Soil; 3, Work on Roots.

older wood. The egg-laying period for the beetles has been observed to extend over a month and a half. During the latter part of July and during August the beetles die, although individuals may be found as late as the first week in September.

REMEDIAL MEASURES.

All efforts to kill the grubs before they enter the soil or while in the soil have proved impracticable. Therefore efforts in control have been directed to destroying the insects before they have an opportunity to lay eggs, which are to produce the next crop of root-worms.

Two general methods have proven beneficial: (1) *The destruction of the pupae*; (2) *the destruction of the adults before they lay their eggs.*

Destruction of the pupae.— A common vineyard practice is the forming of a low ridge underneath the vines during the last cultivation of the summer.

This ridge is removed the following spring by means of an implement called a horse-hoe. This horse-hoeing is done after the vineyard has been plowed and harrowed. *While it is good horticultural practice to remove this ridge during the latter part of May, it is desirable, if root-worms are numerous, to allow this ridge to remain intact until a large number of the grubs have formed pupal cells and then remove the ridge by means of a horse-hoe and follow shortly afterwards with a spring-tooth harrow.* This practice will crush many pupæ and will break many cells, thus exposing the pupæ to the air and sunlight which kills them. If the ridge is not allowed to remain the grubs will form pupal cells nearer the roots and these cannot be disturbed without injuring the roots. Horse-hoeing at the proper time will *not* kill *all* the insects for several reasons: (a) *all the grubs do not form pupal cells at the same time*, there being considerable variation in certain years; (b) *some grubs will form cells too deep to be affected by the horse-hoe.* However this operation constitutes an effective weapon of control, which adds no expense to the vineyardist inasmuch as good cultivation is necessary for a vineyard especially during the months of May, June and July, but it should not be expected to take the place of spraying.

Destruction of the adults.— Economic entomologists have concentrated their efforts for the control of this pest upon the killing of the adults before they lay their eggs. Spraying with arsenical poisons is the practice which has yielded the best results. *Bordeaux mixture* (8–8–100) *with 6 lbs. of arsenate of lead* is used most extensively. This material was believed to poison the beetles, but our experiments have shown that arsenate of lead either alone or with bordeaux mixture is distasteful to the beetles, who appear to avoid such material and feed on the unsprayed portions of the foliage.

If the foliage is thoroughly sprayed the beetles show a tendency to migrate to neighboring unsprayed vineyards. This repellent effect assists, in a measure, in preventing migratory beetles from other vineyards from taking up their abode on the sprayed vines and therefore has justification for its use. Experiments conducted by this Station have shown that the beetles are attracted by the odor of molasses, and by adding one gallon of molasses to 100 gallons of water and 6 lbs. of arsenate of lead the root-worm beetles are attracted and poisoned, but, unfortunately, the addition of molasses destroys the adhesiveness of the arsenate of lead. If a rain occurs within twenty-four hours after spraying, all the material is practically washed from the foliage and very little benefit is derived. The use of this mixture, therefore, necessitates the study of weather conditions if the greatest good is to result.

Recommendations.—If the beetles are not very numerous spray within a week after the appearance of the first beetles, using bordeaux mixture (8-8-100) and arsenate of lead 6 lbs. Repeat this spraying in about ten days. The vines should be thoroughly sprayed. If the beetles are numerous spray as soon as the beetles appear in numbers on the vines, being careful to avoid applying just before a rain, with arsenate of lead 6 lbs., molasses 1 gallon and water 100 gallons. A cheap stock molasses is better than the more refined grades. Spray a second time one week later, using bordeaux mixture (8-8-100) and arsenate of lead 6 lbs. The object in using the sweetened spray is to kill as many beetles as possible with the first application and by means of the second spray to repel what may remain as well as others migrating from other vineyards. Inasmuch as the beetles are more active during warm days, better results have been obtained by applying the molasses mixture on such days providing rains were avoided.

The length of time between sprayings must be determined according to weather conditions. During hot weather the applications should be made with a closer interval than during cool periods. The amount of new growth and the feeding of the beetles must also govern the operations of the vineyardist in spraying. Seasons having numerous heavy showers the latter part of June and early July may make three sprayings necessary in vineyards where the grape root-worm is abundant.

The cumulative effect of bordeaux mixture and arsenate of lead upon the number of beetles is marked. Although this material may not give as decided results as the sweetened spray when used for a single season on a vineyard severely infested with grape root-worm, still the use of this material over a period of years in the same vineyard produces an appreciable decrease in the numbers of these beetles. The author has observed that, in the Chautauqua and Erie Grape Belt, seldom is a vineyard found seriously infested with chewing insects where two thorough sprayings of bordeaux mixture and arsenate of lead have been given annually, at the proper time, for a period of five or more years. If failure has resulted it has practically always been due either to lack of thoroughness in application or to the fact the material has been applied at the wrong time. For these reasons it is believed that growers generally should use the bordeaux mixture and arsenate of lead in preference to any other spray. In cases of severe infestation the sweetened spray can be used to reduce the number of beetles but this should be followed for several seasons with the former mixture. The fungicidal effect of the bordeaux mixture is so important that practically all vineyards would be benefited by its use even though no insects were present. The grape root-worm is not as difficult to control as many grape growers have believed. Intelligent application of the above recommendations will usually hold the insect in control.

SINUATE PEAR BORER AND LEOPARD MOTH.*

P. J. PARROTT AND HUGH GLASGOW.

A recent survey by this Station has established the fact that two destructive insects are being distributed into fruit-growing sections of this State by importations of nursery stock. These are the Sinuate Borer (*Agrilus sinuatus*) and the Leopard Moth (*Zeuzera pyrina*). This circular contains a brief account of the pests, which should be recognizable from the accompanying descriptions and illustrations.

SINUATE BORER.

The sinuate borer, which is of European origin, appears to be confined to the southeastern portion of the State and as far as is known at the present time it is largely restricted to five or six counties that are contiguous to the Hudson River. In certain communities its ravages have been of such a character that it has almost discouraged the planting of pears, and it now promises to exterminate the orchards that were established before the time of its introduction. The adult insect is a small copper-colored beetle about one-third of an inch long (Plate XXXVIII, fig. 2). It makes its appearance during the forepart of June and deposits its eggs in depressions or crevices in the bark of the trunk or branches. Upon hatching, which occurs about the first of July, the larva (Plate XXXVIII, fig. 3) burrows directly from the egg to the sap-wood, where it cuts an irregular serpentine mine (Plate XXXVIII, fig. 1), which is very characteristic and easily distinguishable from that of other borers attacking pear trees. With young trees the presence of the borer is indicated by the splitting or the swelling of the bark, which forms a continuous raised area or welt that parallels the sinuate course of the insect. The girdling of the bark kills the trees or weakens them so that they lapse into a languishable state and become unproductive.

TREATMENT.

Wood-boring insects are generally hard pests to combat, and this beetle, in particular, presents several difficulties which are not usually encountered in a single species. For small trees the most satisfactory method of control is, perhaps, to cut into the mine of the insect and destroy the inmate. The course of the mine can usually be followed by the discoloration and splitting of the bark following the tunneling by the borer. Recent studies by this Station have

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* A reprint of Circular No. 44, December 1, 1915.

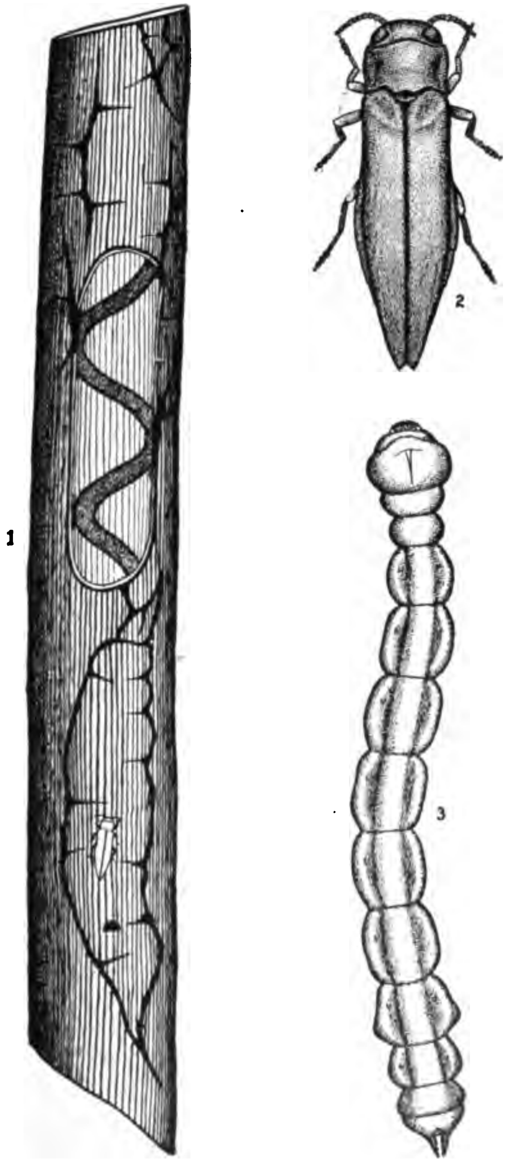

Plate XXXVIII.— Sinuate Pear Borer.
1, work on pear wood; 2, adult; 3, larva.

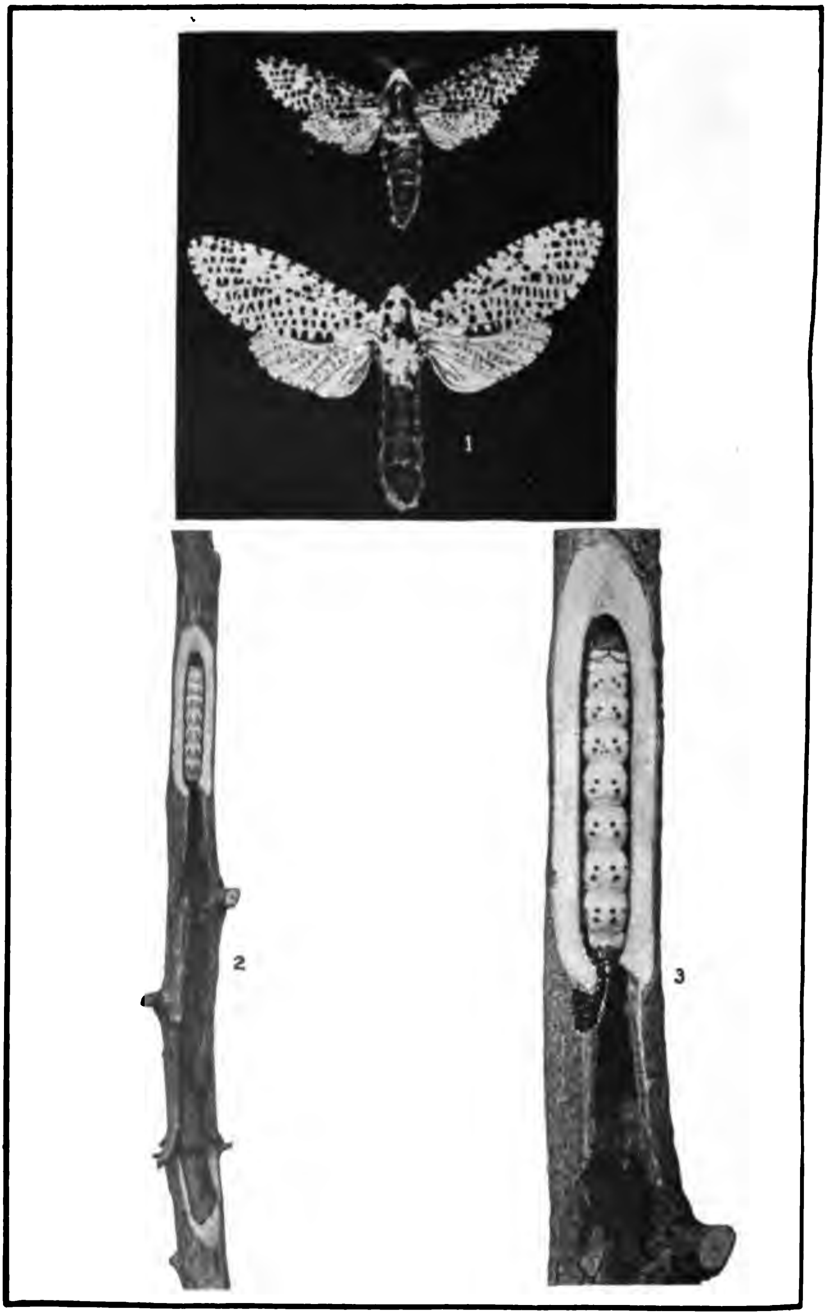

Plate XXXIX.— Leopard Moth.
1, Moths; 2 and 3, tunnels in branches, showing caterpillars.

shown that the beetles feed readily on the foliage, and point to the possibility of successfully controlling the insect by an application of an arsenical spray during the latter part of May or shortly before the beetles commence to appear. Also worthy of trial is an application to the trunks and branches, during early June, of a deterrent wash to prevent oviposition. For bearing orchards these latter measures are recommended tentatively pending the results of our experiments to determine their merits.

LEOPARD MOTH.

As a pest of fruit trees, the leopard moth ranges in the State of New York over much the same territory as described for the sinuate borer. It has been observed in nursery stock of different sorts of trees and in old pear trees in commercial plantings. Its chief damage is caused by the larva or grub (Plate XXXIX, figs. 2 and 3), which inflicts serious injury to branches and trunks by tunneling into them. With trees, such as nursery stock, the larva often bores through the entire stalk. In Europe it attacks common shade and park trees, and has been recorded as destructive to apple, cherry, pear and plum. In the communities in the United States where it is established, the moth is regarded as one of the worst enemies of shade trees.

The adult or moth has an expanse of wings of two to three inches. The wings are white with isolated spots of steel blue color. The female is similar to the male, but is larger and possesses an extensile ovipositor. The popular name given to this insect was obviously prompted by the spotted appearance of the moth. (Plate XXXIX, fig. 1.)

The eggs of the insect are about the size of a pin-head, elliptical in shape, and orange-yellow or salmon in color. They are deposited in crevices in the bark of the branches and trunks. The larva is a yellowish-white or pinkish caterpillar, which attains a length of one and one-half to two inches. The segments bear brown tubercles, which give the caterpillar a spotted appearance. The young larvæ upon hatching seek tender twigs and growing shoots, which they enter. They are mining creatures and burrow their way through the center of a branch or consume as much as one-half the diameter of the wood, leaving merely a shell of bark over their mines, or girdle the wood entirely. The young caterpillars do much damage by seriously injuring or killing young branches. The older caterpillars attack in a similar manner the larger branches and trunks, and form deep, extensive burrows in the wood beneath the bark. When such tunnels are numerous and are contiguous the insect works great havoc, even to large trees. The bark covering the undermined areas eventually disintegrates, forming unsightly scars, or if sufficiently numerous the mines may entirely girdle branches and limbs, causing their death. The loss of the larger wood destroys the symmetry of the trees, giving them a lop-sided effect.

TREATMENT.

The measures employed to combat this pest are in general such as are commonly practised against wood-boring insects: Prune and cut back infested branches and destroy caterpillars in their mines. In case of attack of the twigs and tips of branches by young larvæ remove a few inches of the end of the new growth. Systematically examine trunks and large limbs for " borers " which should be cut out and destroyed. Caterpillars buried deeply in the heart-wood should be killed by probing with a piece of wire or by injecting carbon bisulphide into the burrows, when the openings after application should be immediately sealed with moistened clay or putty. Infested nursery stock should be burned.

REPORT

OF THE

Department of Horticulture.

U. P. Hedrick, *Horticulturist.*
Roy D. Anthony, *Associate Horticulturist.*
Geo. H. Howe, *Assistant Horticulturist.*
Chas. B. Tubergen, *Assistant Horticulturist.*
J. W. Wellington, *Assistant Horticulturist.*
O. M. Taylor, *Foreman.*
Fred E. Gladwin, *Associate Horticulturist.*
(Connected with Grape Culture Investigations.)

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REPORT OF THE DEPARTMENT OF HORTICULTURE.

INHERITANCE OF CERTAIN CHARACTERS OF GRAPES.*†

U. P. HEDRICK AND R. D. ANTHONY.

SUMMARY.

In the last 25 years, during which time nearly 10,000 seedlings have been grown, various changes in the methods used at the Geneva Experiment Station have been made as the knowledge of breeding laws has been extended.

Results have compelled the belief that improved varieties of grapes will not be produced to any extent until the fundamental laws of heredity are understood. The present aim is to discover these laws.

The work is now progressing mainly along two lines: (1) The determination of the breeding possibilities of varieties of grapes and (2) the study and interpretation of breeding phenomena.

Nearly 200 varieties of grapes have been used in the breeding work.

Much of the value of the early work was lost by growing too few seedlings of each cross.

Recently *Vitis vinifera* has been used to a considerable extent in hybridization.

The usual method of emasculation has been ineffective in a few cases and may be open to criticism.

One of the surprises in the study of grape varieties was the failure of many commercial sorts to transmit desirable qualities.

In order to study grape varieties, nearly 3,000 selfed, or pure, seedlings have been grown. These are uniformly lacking in vigor.

The inheritance of those grape characters which have sufficient data available has been discussed in this paper.

Of the two types of stamens, reflexed and upright, the first is correlated with complete, or nearly complete, self-sterility, the second with self-fertility.

Self-sterility is probably caused by impotent pollen. It exists in varying degrees and depends to some extent upon the condition of the vine and environmental factors.

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* Also printed in *Jour. Agr. Research*, 4:315-330, 1915.

† A reprint of Technical Bulletin No. 45, August, 1915.

Self-sterile varieties of grapes being undesirable from a horticultural standpoint, can we eliminate those with reflexed stamens? The following crosses have given upright and reflexed stamens in the indicated ratios:

U × U = 4.3 U:1R
R × R = 1.2 U:1R
R × U = 1U:1R
U × R = ?

Breeding from the upright varieties only will decrease but not eliminate the seedlings with reflexed stamens.

The following seem to be the results secured in the study of sex inheritance:

Hermaphrodite female × hermaphrodite male = all hermaphrodites.

Hermaphrodite female × pure male = ½ hermaphrodites + ½ males.

Two general laws have been formulated with regard to color of the skin: (1) White is a pure color; and (2) it is recessive to both black and red.

No black variety has proved pure for blackness. Some contain white, others white and red. Red varieties are equally diverse.

The colors of pure seedlings of certain varieties show wide variation, even when derived from varieties of similar color.

In the inheritance of quality the most noticeable thing is the low percentage of seedlings whose quality is good or above good. This is probably due to the leveling influence of the wild ancestors from which the seedlings are but a step removed.

Most grapes of high quality possess some *V. vinifera* blood. This predominance of high quality is probably due to the intense selection to which the species has been subjected for centuries.

The pure seedlings on the New York Station grounds have been lower in quality than crossed seedlings.

In the inheritance of size of berry there is no indication of dominance of any one size, though there is a tendency for a variety to produce seedlings approaching its own size.

The oval form of many *V. vinifera* hybrids is probably an intermediate between round and a more pronounced oval. Oblate may be a pure form recessive to round.

The season of ripening of the parent influences to a considerable extent the season of the offspring.

A vineyard of 1,500 seedlings bred from 1898 to 1903 has dwindled through selection to less than 75. Of these, 5 have already proved promising enough to be named.

INTRODUCTION.

The breeding of grapes (*Vitis* spp.) was begun in the Horticultural Department of the New York Agricultural Experiment Station about 25 years ago and has been continued throughout this time as a horticultural problem. Nearly 10,000 seedlings have been grown, and of these about 6,000 have fruited. This work was begun about 1885 by Prof. E. S. Goff, who at first grew seedlings and plants from seeds open to cross-pollination. Later he crossed a number of varieties. In 1891 Prof. S. A. Beach became the Station horticulturist, and besides seeking to obtain new varieties he made studies of self-sterile varieties, studied the correlation between the size of seeds and vigor of plants, and did considerable hybridizing. In 1905 the senior author took charge of the work in horticulture at the Station. Mendel's work had just been discovered, and plant breeding was undergoing a stimulus from it. The work with grapes was therefore replanned and extensively added to with a view to studying problems of inheritance. This work has been continued and increased from year to year. Several assistants and associates have spent much of their time working with grapes at this Station. Mr. N. O. Booth worked with grapes from 1901 to 1908; Mr. M. J. Dorsey from 1907 to 1910; Mr. Richard Wellington from 1906 to 1913; Mr. R. D. Anthony, the junior author, began work at this Station in the summer of 1913, and has devoted most of his time to the grape work since then. Upon him has fallen the task of presenting the data in this paper. It is the purpose of this paper to discuss certain results of this work.

AIMS, METHODS, AND MATERIALS.

During this quarter of a century, experience and a better understanding of the principles of breeding have modified many of the methods and changed considerably the nature of the data which are now taken.

The ultimate aim in this work is, of course, the production of improved horticultural varieties. Through the early days, when breeding laws and methods were less understood than now, there was a tendency to make this the immediate as well as the ultimate aim. The fact that the first twenty years of grape breeding produced but one variety worthy a name served to confirm the conviction that this goal would be reached quicker by forgetting it for the time being and bending every effort to the discovery of how grape characters are transmitted.

The work is now proceeding mainly along two lines: (1) The determination of the breeding potentialities of a considerable number of varieties of grapes, especially with the view of finding unit characters; and (2) a review of all the New York Experiment Station breeding data on this fruit, to study and interpret breeding phenomena, accompanying this review with the making of the crosses necessary to throw further light upon doubtful points.

The results secured in testing the breeding possibilities of grape varieties, which will be discussed later, have made it seem desirable to extend this study to all the varieties which show any promise. For this reason nearly 200 different kinds have been used as pollen parents and nearly 100 as maternal parents in this work.

Frequently during the early days of the work seedlings which seemed to lack vigor in the nursery were discarded, instead of being planted in the test vineyards. Though this undoubtedly removed many unpromising seedlings, it seriously decreased the number which fruited, and made the interpretation of results difficult and uncertain. At best the number of seedlings that lived of each cross was smaller than could be desired, and, when this number was still further decreased by selection in the nursery or by untoward circumstances, much of the value of the work from a breeding standpoint was lost.

Another change of method which bids fair to be exceedingly important has been the use of varieties of *Vitis vinifera* in breeding. Every indication points to the desirability of the addition of some of the blood of the European grape to our native sorts. Although we are working primarily to determine breeding laws, there is usually a wide choice of varieties which answer our purpose, and with the growing of nearly 100 varieties of this species on the New York Station grounds we have been able to use several as parents. There are now several hundred hybrids containing *V. vinifera* blood growing on the Station grounds, and these will be increased by many hundreds during the following years.

The methods used in the actual work of crossing are similar to those of most breeders. The female blossoms are emasculated before the calyx cap splits off and are then bagged; the male blossoms are also bagged before the calyx splits. When the pollen is ripe, the bagged male cluster is usually cut from the vine and all or part of it brushed over the emasculated female. Usually some of the male cluster is inclosed in the bag, which is again put over the female after pollination. In a few cases, where the periods of blossoming of two varieties are too widely separated, it has been necessary to save pollen in clean glass jars. It is customary to dip the forceps used in pollination into alcohol with each new variety.

Certain results secured in the summer of 1914 seem to indicate that this method is perhaps open to criticism. While emasculating clusters of the Janesville variety it was found that, although the cap had not split, the pollen in the anthers seemed to be mature, and, as the anthers were ruptured during the emasculation, there was a possibility of self-fertilization taking place. Several clusters were emasculated and bagged without being pollinated. These set nearly the full quota of berries with seeds that have every appearance of being viable. With two other varieties, clusters emasculated and not pollinated matured a few plump seeds, though the clusters were much below normal. A somewhat similar instance is reported by Beach (1),[1] the variety being the Mills. This point deserves careful study, for if it is found that serious danger of self-pollination exists before the calyx cap splits it will be necessary to change the method — at least to the extent of emasculating the clusters several days before the cap is ready to come off.

All data regarding size and shape have been recorded in comparative terms, instead of the actual measurements being taken. With a limited number of observers and thousands of seedlings of the various fruits to be studied each year, it was a physical impossibility to take measurements and would not have increased the value of the records to any extent from a horticultural point of view, though it would, of course, have furnished interesting material for a statistical study. The value of data reported in comparative terms depends upon the accuracy of the recorder. The work with the grape has always been done by members of the scientific staff, and the observations have usually been checked during several seasons.

GENERAL RESULTS OF THE STUDY OF VARIETIES OF GRAPES.

One of the surprises in the study of varieties of grapes was the failure of many of our commercial sorts to transmit desirable qualities to their progeny. Seedlings of Concord, Niagara, Worden, Delaware, and Catawba grapes have so far proved only disappointments. The best results have been secured from such little-grown varieties as the Ross, Collier, Mills, Jefferson, Diamond, and Winchell. This has made it seem desirable to test all varieties that show any promise. The first step, then, was to secure as many varieties as possible which were of any value and which could be grown in northeastern United States. More than 400 such varieties have fruited in the Station's vineyards and have been described. About 200 of these have been used to a greater or less extent in the breeding work.

As an aid in studying the breeding possibilities of grape varieties the Station has grown nearly 3,000 selfed, or pure, seedlings, using as parents most of those varieties which have entered into the crosses that have been made. These seedlings have thrown much light upon the inheritance of various factors, but they have been so uniformly lacking in vigor as to lead to the belief that only through crossbreeding can we hope to produce improved varieties.

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[1] Reference is made by number to "Literature cited," p. 505.

INHERITANCE OF CHARACTERS.

The grape characters discussed in the following pages are those for which sufficient data are available to make such a discussion of value.

SELF-STERILITY.

On the basis of flower type, grapes may be divided into three classes: (1) True hermaphrodites; (2) hermaphrodites functioning as females, owing to completely or partially abortive pollen; and (3) pure males with the pistil absent or rudimentary. Among these classes there are two types of stamens: Those with upright filaments and those in which the filaments bend backward and downward soon after the calyx cap falls off. According to Dorsey (5), this is due to the cells of the outer surface of the reflexed stamens being smaller and having thinner walls.

So far as observed at the New York Station, all pure males have upright stamens. Among the two classes of females Beach (1) found that only those varieties with upright stamens were capable of producing marketable clusters of fruit when self-fertilized. At the same time he reported nine varieties with upright stamens to be self-sterile. Since Beach published his report further work at this Station with three of these nine varieties has proved them self-fertile, and it is probably safe to say that all varieties with upright stamens are self-fertile, though in varying degrees. Reflexed stamens are always correlated with complete or nearly complete self-sterility. Reimer and Detjen (6) found this last conclusion to hold also with *Vitis rotundifolia*, a species not studied at this Station.

The cause of self-sterility in varieties with reflexed stamens seems to be a lack of viability in all or a larger part of the pollen of such varieties. Booth (2) found that such pollen was quite irregular in form and would not germinate in sugar solutions. Reimer and Detjen (6) state "the pollen of all the present cultivated [female] varieties [of *V. rotundifolia*] is worthless." Recently Dorsey (4) has ascribed the cause of this self-sterility to a degeneration in the generative nucleus. While this impotency may be absolute in many of the varieties, in some at least it is only relative. Frequently viable pollen will be found mixed with the usual misshapen, abortive pollen of the self-sterile varieties, and nearly a hundred pure seedlings of the varieties which Beach (1) reported as totally self-sterile have been grown in the Geneva Station vineyard. The degree of sterility seems to depend to some extent upon the condition of the vine due to environmental factors.

From a practical standpoint it is undesirable to grow self-sterile varieties. They will not succeed in the large blocks of the commercial plantation, nor are they always properly fertilized in the small home vineyard. Can we, then, in our grape breeding eliminate self-sterility? Letting U stand for upright stamens and R for reflex, the following table gives the results of our crosses:

U × U[*] = 180U + 47R	R × R = 16U + 16R	R × U = 207U + 206R
U selfed = 691U + 152R	R selfed = 94U + 73R	Ratio.........1U:1R
		U × R = ?
Total....871U + 199R	Total....110U + 89R	
Ratio.........4.3U:1R	Ratio.....1.2U:1R	

Of the varieties whose pure seedlings have entered into the ratio of 4.3 U to 1R, only two, involving 18 seedlings, have given simply upright stamens; consequently it may safely be said that no variety has proved pure for upright stamens. In the remaining crosses of this class the ratios have ranged from 1U to 2R up to 10U to 1R, with the greatest frequency at 2U to 1R. The results with the crossed seedlings are practically the same. Over a thousand seedlings from crosses of one type would be expected to give some rather definite results; yet these results are anything but definite, and apparently no conclusions can be drawn from them except that the varieties are not homozygous for uprightness of stamens.

The ratio of practically 1 to 1 in crosses of varieties with reflexed stamens is perhaps best accounted for by the supposition that the gametic composition of pollen and ovules is not alike. The ratio of 1 to 1 in crosses of reflexed by upright stamens may be covered by the same assumption. It should be noted that the pollen of the upright varieties produces the same ratio as that of the reflexed varieties when both are used on ovules of the reflexed kinds.

Upright varieties have been crossed many times with reflexed sorts and several hundred seedlings should have resulted from these, yet only one plant has survived the vicissitudes of the seed bed and nursery to be planted in the test vineyards. In the last five years 50 crosses have yielded 600 seeds; yet from these there are now in the nurseries but 25 living seedlings. Many of the pollen parents used in these crosses were the same as those used in the cross R × R. In the two crosses R × R and R × U, the pollen from upright and reflexed varieties produced the same results; but comparing this last case, U × R, with the first one, U × U, we see that the pollen of the upright and reflexed varieties has produced quite different results when used on upright sorts. Why this should be is not apparent.

At present there does not seem to be any way of eliminating reflexed stamens, but we can at least decrease the proportion by using for breeding only varieties with upright stamens.

INHERITANCE OF SEX.

Among more than 6,000 seedlings which have flowered in the New York Experiment Station vineyards, less than 100 pure male vines have been found. Of these there are complete breeding records for 62 vines, 51 of which came from crosses in which the pollen parent was a pure male, leaving 11 males recorded as produced by pollen from hermaphrodite plants. Of these, 5 were pure seedlings from one parent, the other 6 from 5 crosses. These 6 were probably hermaphrodites erroneously recorded as males, an error very easy to make when the pistil has a short style and one which has been made several times and corrected by subsequent observations. The parent yielding the 5 males was discarded shortly after being used in breeding, and our records are meager. It was probably an intermediate recorded as a hermaphrodite. Such an intermediate, having both male and hermaphrodite blossoms, is under observation in one of the Station vineyards, and its pollen seems to behave as the pollen of a pure male; in other words, it is reasonable to assume that, excluding these intermediate forms, pollen from hermaphrodite plants will not produce pure males.

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[*] The pollen parent is always placed last.

The results obtained from pure males as pollen parents are:

Hermaphrodite female × pure male = 56 hermaphrodites + 51 pure males

Following the assumptions usual to such cases, the hermaphrodite would be considered a sex heterozygote and the male a sex homozygote. Yet selfed hermaphrodites yield only hermaphrodites. These results are similar to those obtained at this Station from selfed hermaphrodite strawberries, but differ from Shull's results (7) with species of Lychnis, where the hermaphrodite gave both females and hermaphrodites. This condition might be covered by the assumption that the hermaphrodite is a female in which the addition of a single dose of maleness has caused the production of male organs, the ovules keeping the composition ♀ ♀ and the pollen becoming ♂ ♀:

Hermaphrodite × hermaphrodite = ♀ ♀ × ♂ ♀ = 2♂ ♀ + 2 ♀ ♀

Since we have no pure females, we must assume that some condition prevents the formation of individuals with the composition ♀ ♀; therefore, the above cross gives only hermaphrodites. Of course, if we do not attempt to assume the method of origin of the hermaphrodite, the case may be covered by considering the hermaphrodites pure for this character, while the males would be heterozygous:

☿ ☿ × ☿ ☿ = ☿ ☿
☿ ☿ × ☿ ♂ = ☿ ☿ + ☿ ♂

COLOR OF SKIN.

Colors of grapes are not sharply differentiated, grading from white through many shades of red and purple to black. Because of this wide range, the problem of finding varieties which are pure for certain colors has been greatly complicated, yet until we are able to find such pure colors and to study their various combinations our knowledge of the color composition of many varieties will probably be only conjectural.

The thousands of seedlings which have been fruited have made possible the formulation of but two general laws: (1) White is a pure color; and (2) white is recessive to both black and red. White, yellow, green, and amber are all considered under the one term and are regarded as being the absence of red and black.

No black variety that has been tested to an extent sufficient to make the results at all conclusive has proved pure for blackness. Some have a factor for red; others seem to contain only black and its absence, white, while still others have both white and red progeny.

In order to simplify the study of red varieties, it has seemed best to divide the seedlings into two shades, the light or medium reds and those ranging from dark red to purple. Those in the second classification are probably red plus either an intensifying factor or various amounts of black. Such a division is somewhat arbitrary and some colors are difficult to place, but, in general, it is a helpful arrangement. Table I gives the result of combining similar colors and shows that results obtained from crosses of red varieties are as diverse as those from crosses of blacks. The table includes mainly pure seedlings.

TABLE I.— RESULTS OF CROSSING GRAPES OF SIMILAR COLORS.

COLORS OF PARENTAL TYPES.	COLORS OF SEEDLINGS.			
	Black.	Purple to dark red.	Medium to light red.	White.
White × white	....	....	....	166
Light red × light red	8	6	13	8
Dark red × dark red	38	43	45	42
Black × black	407	49	13	54

Table II illustrates the variation in color composition among most of the varieties given above in the cross black × black and shows the number of varieties which fall in similar groups. From this table it will be seen that 15 black varieties have given only black seedlings, but the number of seedlings is not large enough to be conclusive.

TABLE II.— COLOR GROUPS OF PURE SEEDLINGS OF BLACK VARIETIES OF GRAPES.

NUMBER OF PARENTAL VARIETIES.	COLORS OF SEEDLINGS.		
	Black.	Red.	White.
6	52	16	29
6	128	31	....
10	71	....	25
15	132	....	....

It is interesting to note that the parents with only black and white seedlings produce these colors in the ratio of 3 to 1 and that the seedlings of the varieties yielding only black and red are reasonably close to this same ratio.

The results when different colors are combined are given in Table III. The range of color in the seedlings again emphasizes the necessity of knowing more of the color composition of a variety than can be determined from its appearance.

TABLE III.— RESULTS OF CROSSING GRAPES OF DIFFERENT COLORS.

COLOR COMBINATIONS OF PARENTS.*	COLORS OF SEEDLINGS.			
	Black.	Purple to dark red.	Medium to light red.	White.
White × dark red †	5	44	14	50
White × black	41	3	3	12
Black × dark red	100	52	40	32

* Light-red varieties were not used to an extent sufficient to make the results of value.

† The reciprocal cross is included in each case.

It would take up altogether too much space to report upon the color of the progeny of all the varieties studied, but a few of the more common ones are given in Table IV, in order to show the wide variation in different varieties of similar color.

TABLE IV.—VARIATION IN COLOR OF PURE SEEDLINGS OF CERTAIN VARIETIES OF GRAPES.

PARENT.		PURE SEEDLINGS.			
Name of variety.	Color.	Black.	Purple to dark red.	Medium to light red.	White.
Agawam	Purple red	1	2	....	2
Brighton	Dark red	6	5	9	7
Catawba	Purple red	2	4	3	4
Champion	Black	13	1	1	2
Clinton	Black	15	....	....	7
Concord	Black	40	6	....	12
Essex	Purple black to black	4	2	3	....
Hartford	Black	4	....	1	3
Hercules	Black	3	1	1	10
Isabella	Black	8	....	....	1
Merrimac	Black	9	3	6	....
Nectar	Black	4	5	2	....
Ozark	Black	16	....	....	....
Pearl	White	......	....	....	15
Regal	Dark red	......	....	15	5
Worden	Black	4	3	....	1
Wyoming	Dark red	1	4	2	3

In the ultimate solution of the problems of color inheritance we shall probably be aided in no small degree by those who are studying the subject from the standpoint of the chemistry of the various colors; thus, Wheldale (8) has isolated two anthocyanins from species of Antirrhinum which produce different shades of red and three flavones for ivory, yellow, and white. Some work has already been done along this line with the grape. Dezani (3) has found two chromogenic substances in white grapes, and several have reported work on the coloring matter of red grapes, but apparently the results are as yet too indefinite to be of much value to the breeder.

INHERITANCE OF QUALITY.

At first thought it would seem useless to attempt a study of such an elusive and composite character as quality the interpretation of which depends so much upon the tastes of the observers; yet in the final analysis it is this character which very largely determines whether a seedling is worth saving or must go to the brush pile, and any addition to our knowledge of its inheritance is worth the effort.

Table V shows the rating of the progeny of various parental combinations which run the gamut of quality. Most noticeable is the very low percentage of seedlings whose quality is good or above good even when parents of the highest quality were used. When we consider the ancestral history of these seedlings, these results are not surprising or discouraging. Our American grapes, except for the *V. vinifera* hybrids, are but a step removed from the wild, only a few possessing sufficient quality to make them stand out from the many thousands too poor to be eaten with relish. In breeding from these we are breeding from the topmost point of the species and the effect of the several hundred poor kinds in the immediate ancestry is to pull the seedlings down toward the " level of mediocrity."

TABLE V.— INHERITANCE OF QUALITY IN GRAPES.

PARENTAL TYPES.	TYPES OF PROGENY.											
	Best.	Very good to best.	Very good.	Good to very good.	Good.	Total good to best.	Fair to good.	Fair.	Medium.	Poor.	Total, poor to best.	Percentage of good or better.
Very good to best × very good	....	......	....	2	9	11	4	7	....	1	23	48
Very good × very good	....	1	7	5	22	35	8	24	3	14	84	41
Very good × good to very good	....	......	2	8	30	40	9	30	2	20	101	40
Very good × good	....	......	....	3	6	9	3	43	7	23	85	10
Good to very good × good to very good	....	......	1	6	43	50	20	48	6	36	160	31
Good to very good × good	....	......	1	......	2	3	8	38	2	15	66	4
Good × good	....	1	5	3	31	40	18	59	15	31	163	24
Good × fair	....	......	....	1	3	4	1	6	1	4	16	25
Fair to good × poor	....	......	....	......	2	2	5	9	1	23	40	5
Medium × medium	....	......	1	3	18	22	14	54	20	103	213	10
Poor × poor	....	......	....	1	1	2	....	7	2	40	51	4
Total number of progeny	....	2	17	32	167	218	90	325	59	310	1,002	21

The tendency for the proportion of seedlings of good quality to decrease as we use parents of poorer quality shows clearly the importance of breeding from varieties of only the highest excellence, and even then we must be reconciled to a relatively small percentage of seedlings of good quality.

Practically every grape in the vineyards of the New York Station which ranks high in quality possesses some blood of *V. vinifera*. A moment's consideration of the history of the species shows us the reason for this predominance. European grapes are centuries removed from the wild and have been subjected to a more intense selection than any other fruit; the " level of mediocrity " has been raised to such a point that the species has become a powerful factor in transmitting high quality.

In this connection it is well to speak again of the future that lies ahead of the breeder who will search out and use those varieties of this potent species which blend best with our hardy native kinds. The ages of selection and breeding in Europe have developed varieties of this one species adapted to nearly as wide a range of climate as is covered by all our native species taken together. The proper selection of parents among these should enable us greatly to extend and enrich our viticulture.

A considerable proportion of the seedlings the results of whose crossing are given in Table V are pure seedlings. These have been separated and tabulated in Table VI. Comparing the percentage of those pure seedlings which are good or above good in quality with the percentage of the remaining similar cross-bred seedlings shows an interesting condition. The pure seedlings are uniformly poorer in quality than the crossed seedlings. Is this due to the decrease in vigor which seems to follow selfing, or is there some weightier reason?

TABLE VI.— QUALITY OF PURE SEEDLINGS OF GRAPES.

PARENTAL TYPES.	TYPES OF PROGENY.				
	Good or above good.	Below good.	Total.	Percentage good or above.	Percentage of crossed seedlings good or above.
Very good × very good	14	25	39	36	47
Good to very good × good to very good	6	26	32	19	34
Good × good	33	102	135	24	25
Medium × medium	17	147	164	10	17
Poor × poor	0	31	31	0	10
Total	70	331	401	17	31

SIZE OF BERRY.

In order to economize space it was necessary to plant the seedlings so close together in the test vineyards that the clusters frequently did not reach full and characteristic size. For this reason the size of cluster can not be discussed, although it is an important factor. The size of the berry, on the other hand, is one of the size factors least influenced by environment and season. The data from these vines should be of value and are presented in Table VII.

TABLE VII.— INHERITANCE OF THE SIZE OF THE GRAPE BERRY.

PARENTAL TYPES.	CLASSES OF SEEDLINGS.						
	Very small.	Small.	Below medium.	Medium.	Above medium.	Large.	Very large.
Large × large.............	1	2	3	*28	*28	19	8
Large† × medium to large‡..	1	6	7	56	34	*67	6
Large × medium...........	......	1	......	*4	2	2	....
Medium to large × medium to large.................	5	34	35	*103	59	20	4
Medium to large × medium..	......	20	35	*57	37	3	2
Medium × medium.........	4	49	39	*83	38	11	....
Medium to large × small....	......	*13	11	12	12	8	....
Medium to small × medium to small................	26	*35	12	23	7	......	....
Small × small.............	5	*16	4	5	3	......	....

* Numbers in the bold-face type represent the mode.

† The reciprocal is included in each cross.

‡ The use of the two terms shows that the berries varied from medium to large in the same variety.

A study of the various crosses which have entered into Table VII has failed to show any indication of purity for size among the varieties studied. Lacking exact measurements for the various sizes, it is not possible to compute an accurate mean, but the relative position of the mean with respect to the mode can be determined by a short study of the table. The wide variation about the mean, even in crosses where both parents were of the same size, prevents the only cross made between extremes of size, medium to large × small, from showing any clear tendency for the F_1 progeny to be intermediate. The steady decrease in the mean and mode as the parental types grow smaller shows clearly the strong tendency for a variety to produce progeny centering around its own size.

FORM OF BERRY.

The ovalness of many varieties of *V. vinifera* is so pronounced that some have given this as a species characteristic and have assumed that ovalness in our American grapes was an indication of the presence of blood of this species, an assumption hardly warranted by the facts. The large number of markedly oval varieties among table varieties of *V. vinifera*, together with the complete or nearly complete loss of this extreme form in hybrids with our American grapes, would lead us to suppose that this pronounced ovalness is perhaps a nearly pure form and that it is either recessive to roundness or else unites with roundness to produce a less pronounced oval. It is this latter type of oval that is referred to in Table VIII showing the inheritance of berry form. The appearance of so many seedlings with round berries in crosses of such oval varieties would tend to strengthen the idea that this is an intermediate form.

Any study of oblateness is made uncertain by the small number of varieties that possess this form. One of the most pronounced is the Goff, a seedling originated at this Station. The behavior of pure seedlings of the Goff grape would seem to indicate that, in this variety at least, oblateness is a pure form and its disappearance when combined with round, as is shown in Table VIII, would seem to show it as recessive to round.

TABLE VIII.— INHERITANCE OF FORM OF THE GRAPE BERRY.

PARENTAL TYPES.	TYPES OF PROGENY.						
	Oblate.	Slightly oblate.	Oblate to round.	Round.	Round to oval.	Slightly oval.	Oval.
Oval × oval	......	1	1	*15	7	2	11
Oval × round to oval	......	......	......	*56	10	15	10
Round to oval × round to oval	3	3	10	*129	30	25	56
Round × oval	......	......	......	*15	1	6	3
Round × round to oval	......	1	2	*100	9	14	1
Round × round	10	17	22	*333	34	24	17
Round to oval × round to oblate	3	......	1	*17	2	2	1
Round × round to oblate	......	4	2	*42	5	2	1
Round to oblate × round to oblate	8	......	1	*24	2	1	8
Round × oblate	......	......	......	7	......	......	......
Oblate × oblate	*15	......	......	1	......	......	......

* Numbers in bold-face type represent the mode.

From a study of Table VIII it is seen that the mean would be more nearly coincident with the mode in each cross than was the case in Table VII. This shows clearly the strong tendency for roundness to obscure both oval and oblate.

SEASON OF RIPENING.

The period of ripening of a variety depends so much upon the vigor of the vine, the season, cultural methods, and environmental conditions that no very accurate data can be presented. In one year all varieties may be 10 days earlier than normally, while in another year early varieties may be unusually early; but a cold, wet period late in September and early in October may cause the late varieties to be unusually late. These variations are minimized when the records extend over a number of years. The ripening dates of the seedlings are usually taken for at least three years — not long enough, but much better than if taken for a single year.

In Table IX the ripening season extends approximately through the months of September and October. The first two periods cover about 15 days each, the next two about 10 days each, while the length of the last period is usually fixed by the first killing frosts.

TABLE IX.— EFFECT OF HEREDITY ON SEASON OF RIPENING OF GRAPES.

PARENTAL TYPES WITH REFERENCE TO RIPENING SEASON.	RIPENING PERIODS OF PROGENY.					
	Approximate mean.	Very early.	Early.	Early mid-season.	Mid-season.	Late.
Early × early	Sept. 23	8	*30	20	......	.....
Early × early to midseason †	Sept. 22	13	*46	18	......	.....
Early to midseason × early to midseason	Sept. 27	7	*46	42	7	1
Early × midseason	Sept. 28	......	20	*22	......	.....
Early to midseason × midseason	Sept. 26	21	*126	100	8	.....
Midseason × midseason	Oct. 1	11	165	*244	49	.....
Early × late	Oct. 1	......	8	8	......	.....
Early to midseason × late	Sept. 27	2	*9	2	......	3
Midseason × late	Oct. 4	3	20	*27	18	6
Late × late	Oct. 7	......	10	*104	19	14

* Numbers in boldface type represent the mode.
† Each cross includes also the reciprocal.

As would be expected, Table IX fails to show purity or dominance for any one season, but it does show, both in the mode and in the approximate mean, the extent to which the season of the parent influences the offspring. A study of the varieties which enter into the table has failed to show results at all different from those of the group in which they fall.

NEW VARIETIES FROM EARLIER CROSSES.

The results of the first 20 years of work were anything but encouraging. Now, however, there is tangible evidence that progress is being made. A vineyard of 1,500 seedlings bred from 1898 to 1903 has by a process of vigorous selection decreased to less than 75 vines, but among this number are several that seem very promising. Five of these have already proved so desirable both at Geneva and in a test vineyard at the Station's Vineyard Laboratory at Fredonia, N. Y., that in the fall of 1914 it was decided to give them names and place them in the hands of the nurserymen.

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EFFECT OF VARIOUS DRESSINGS ON PRUNING WOUNDS OF FRUIT TREES.*

G. H. HOWE.

SUMMARY.

1. Fruit growers have long used paints, tars, waxes and other substances as coverings for wounds of trees. This bulletin is a report of the effects of these various substances on wounds made on the apple and on the peach.

2. The substances used as coverings were white lead, white zinc, yellow ochre, coal tar, shellac and avenarius carbolineum. The dressings of these materials were applied when the pruning was done at different seasons of the year and upon wounds of various ages.

3. In all cases undressed pruning wounds have healed more rapidly than those whose surfaces have been protected.

4. Shellac seemed, the first season, to exert a stimulating influence upon the wounds but the second season this effect disappeared. Of all the materials used shellac was least injurious. On the other hand it adheres to the wounded surfaces least well of all.

5. Avenarius carbolineum and yellow ochre caused so much injury that neither substance should ever be used.

6. Coal tar not only caused injury but quickly disappeared either through absorption or evaporation.

7. White lead and white zinc caused some injury at the time of application but the wounded tissues recovered rather quickly and at the close of the first season the injury was not very marked; at the close of the second season it had nearly disappeared. These two paints are the best of the protective substances used and of the two white lead is the better.

8. Nothing is to be gained in the treatment of wounds in waiting several weeks before applying any of the various dressings used in these experiments.

9. The treatment of peach tree wounds with any of the substances under experiment caused so much injury that it may be said that

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the wounds of the peach should never be treated with any of them and it may be inferred that this is true of wounds on trees of all stone fruits.

10. There is nothing to show in this experiment that it is worth while to treat wounds, large or small, of tree fruits with any of the substances in common use. Had there been a longer period of observation, it might have developed that the wood exposed in the larger wounds would have been somewhat saved from the decay which often sets in on exposed wood of fruit trees. It may prove to be worth while, therefore, to cover large wounds; in which case white lead is undoubtedly the best dressing to use.

INTRODUCTION.

Fruit growers have long used paints, tars, waxes and other substances as coverings for wounds of trees. Curiously enough, comparative tests of the many compositions in use seem not to have been made to ascertain the value of these dressings. Tree pruners seem to have taken it for granted that some covering was necessary, for large wounds at least, and have applied the most suitable material at hand. Two theories suggest treatment of wounds. One is that cut surfaces of trees would heal more quickly if some substance be applied to act in the nature of a salve to a sore; the other, that a covering to the wound prevents the entrance of fungi and insects. A moment's reflection shows that if these purposes are served by any of the numerous substances used, some must be better than others. To determine whether any covering at all is needed and, if so, which is best, experiments were begun at this Station in 1911 and carried on for four years.

The trees used in these experiments were apples and peaches. The apple was taken as a representative of the pome fruits, it being assumed that the pear and quince would behave in much the same manner. The peach was taken as a representative of the stone fruits, although fruit growers seldom think it necessary to cover wounds of these fruits since the cuts made are usually smaller and heal more quickly, as a rule, than those made on trees of the pomes. It was thought, however, that the knowledge as to the effects of the various substances on wounds of the peach would be interesting and perhaps profitable.

The substances used as coverings in the experiments were those most commonly recommended for orchard work; namely, white lead, white zinc, yellow ochre, coal tar,[1] shellac and avenarius carbolineum.[2] The lead and zinc were standard brands and were mixed with raw linseed oil. The dressings were applied at different periods and upon wounds of various ages. Thus, certain trees were pruned in winter and treated at once, while others were left six weeks before being covered; other trees were pruned in the spring and immediately covered. The experiments divide themselves, therefore, into the four following heads under which they will be discussed:

I. The immediate treatment of winter-pruning wounds of apple trees.

II. The delayed treatment of pruning wounds of apple trees.

III. The immediate treatment of spring-pruning wounds of apple trees.

IV. The immediate treatment of winter-pruning wounds of peach trees.

I. IMMEDIATE TREATMENT OF WINTER-PRUNING WOUNDS OF APPLE TREES.

About the first of March, 1911, a number of standard varieties of apple trees grown upon dwarf stock and eight years from setting were pruned and the wounds treated at once. None of the wounds were over two inches in diameter. Groups of seven trees each were treated with white lead, white zinc, yellow ochre, coal tar and shellac. From two to three wounds were protected on each tree with an equal number left untreated to serve as checks. All of the trees were hardy and healthy and were making a strong, vigorous growth. The pruning was done as generally practiced in commercial orchards. Thick coatings of the materials used were applied to the wounds and the cut surfaces were all thoroughly covered, but care was taken to prevent the dressings from trickling down the trunks or branches.

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[1] Coal tar or gas tar, as it is frequently called, is the residual tar obtained from the distillation of bituminous coal used in gas making. There are so-called "coal tar" preparations which are produced by dissolving certain asphaltum compounds in gasoline or naphtha but such preparations were not used in these experiments.

[2] Carbolineum, derived from the Latin words *carbo*, coal, and *oleum*, oil, to make a fancy name for a new commodity, is a distillation from coal tar or bituminous shale, containing phenoloid hydrocarbons of a highly preservative nature. The material used in these experiments is sold under the trade name avenarius carbolineum, from the fact that Richard Avenarius, a German, first recommended carbolineum as a wood preservative.

At the end of the growing season of 1911, all of the wounds had healed more or less. Some of the smaller cuts showed a considerable amount of newly formed bark. In all cases the wounds which had been treated with the several substances, except shellac, showed that some of the cambium tissues at the lower edge of the cut surfaces had been injured, thereby increasing the size of the wounds. No such injury was apparent upon the untreated wounds or those coated with shellac. The exposed surfaces of the untreated wounds were all more or less cracked and checked due to drying out caused by the action of sunlight and atmospheric factors. No appreciable difference could be noted in the amount of healing of the smaller wounds, whether treated or untreated. With those of greater diameter, however, there was a slightly increased bark growth on the untreated wounds and those dressed with shellac.

At the close of the growing season of 1912, practically two years after the experiment was started, the majority of the wounds were nearly or completely healed. In some few cases cankers had started, either at the point of the wound or on the trunk or an adjoining branch. Cankers were as often found on the treated as on the untreated wounds. For the most part, however, the trees remained healthy, and normal growth had ensued. It was found that owing to the enlargement of the wounds treated with ochre, lead and zinc, much of the surface of the larger wounds still remained bare. The sides and top of the cut showed the greatest amount of new bark with less growth at the base where the material had collected. Coal tar caused a slight injury in several cases. There was no such injury where shellac had been used. The lead and zinc still remained intact over the surfaces of the unhealed wounds, leaving no cracks or crevices. Much of the shellac, however, had crumbled away leaving the wounds so treated somewhat dried out. Even the ochre and tar had been considerably affected by the weathering. As a whole the results were better upon the untreated wounds than upon those covered with the various preparations other than shellac.

Early in March, 1912, a number of seedling apple trees seven years from planting were treated with the same preparations used in the first experiment. Here again wounds up to two inches in diameter were made. Groups of four trees, each with three or four wounds, were used for the different substances; while eight adjoining trees were pruned and the wounds left untreated to serve as checks. The wounds made were for the most part upon the trunk or at the base of some of the larger branches. At the close of the growing season of 1912, newly formed bark was formed on the majority of the wounds, whether treated or not. Injury was again very apparent on all wounds treated with ochre, lead, zinc and coal tar. No injury was found where shellac had been applied. On the contrary this substance had seemingly stimulated growth, there being, apparently, a greater amount of callus formation on these wounds than on those which had not been treated. All of the untreated wounds showed a cracked and checked surface due to drying out. Some of the smaller ones were already nearly covered over and on none was there any indication of fungi.

At the end of the next season, 1913, final observations revealed a condition not unlike that found the second year in case of the preceding experiment. The wounds upon which shellac had been used and those which had received no treatment showed the greatest amount of new growth. Fully half of the total number of such wounds were practically closed in. There seemed to be no perceptible difference between the amount of healing of those treated with shellac and those left as checks. The first year, shellac seemed to stimulate growth slightly but this was not apparent the following season. At the time of examination most of the shellac had scaled off leaving the unhealed wounds somewhat cracked and dried out. The wounds treated with ochre, lead, zinc and tar all showed evidences of injury caused at the time of application. While practically all wounds were forming some new bark, the basal portion was in every instance relatively poorly healed. The substances used still remained intact, except that the tar had partly disappeared owing to absorption and evaporation. Much of the ochre had also disappeared. This material seemed to cause the most pronounced injury, lead and zinc being somewhat less harmful but each of the two to practically the same degree.

These experiments were further supplemented by another of similar nature in 1913. Early in March, wounds made upon a number of standard varieties of apple trees averaging 30 years old were treated with yellow ochre, white lead, white zinc, coal tar, shellac, and avenarius carbolineum. Wounds were dressed with the various materials on groups of four trees, each with from two to three wounds, while an equal number of wounds were left untreated to serve as checks. Since it had already been proved that small wounds heal more readily without any treatment, in this experiment wounds 3½ to 5 inches in diameter were made. It is, of course, obvious that the larger the wound the longer will be the time required for its healing and the greater will be the danger of the entrance of fungi and insects.

At the end of the season it was found that of all the preparations used on the large wounds, shellac was the only one which caused no injury, and even this, in case of one wound heavily coated with it, caused a slight killing of the cambium tissues. On the other hand, shellac usually stimulated growth and, as a rule, the wounds so treated the first year seemed to have healed somewhat better than the checks. The untreated wounds, however, were all in good condition and, although more or less cracked and dried out, were free from any fungus. These wounds had made a greater progress in the formation of a new woody covering than any of those treated with preparations other than shellac. Of all the substances detrimental to the formation of a covering, avenarius carbolineum stood at the head. In fact, this substance was so injurious to the tissues, not only at the base but entirely around the wound, that there had been little or no healing. Even the woody tissues appeared dead owing to the absorption of the material. Carbolineum may be an excellent preservative but as a dressing for pruning wounds it is most injurious. All of the other wounds treated with ochre, lead, zinc and coal tar showed some injury but many had started new bark formation. Of these others, those treated with tar presented the smallest amount of injury while those upon which ochre was used exhibited the greatest amount. The lead and zinc caused a considerable killing of cells around the entire cut surface although this was most pronounced at the base. In fact the bark immediately surrounding the base where the paint had collected was frequently dead. Some new bark, however, was found around most of the wounds so treated.

At the close of the season of 1914 final observations were made upon these trees. In every case the untreated wounds had made a better formation of new bark than those covered with the various materials other than shellac. Practically no difference could be determined between the amount of new bark formed upon wounds of these two classes. While the shellac had in the majority of instances nearly all flaked off leaving the unhealed surfaces of the wounds somewhat cracked, this cracking was not as apparent as on those receiving no treatment. Although only the smaller wounds were considerably healed, in no instance were any of the untreated wounds failing to make some growth. Occasionally here and there a wound rather poorly made, or upon a branch lacking vigor, was failing to heal rapidly but there were no evidences of any fungus attacking or entering such wounds. It should be remembered that these trees were relatively old and the healing process was naturally much slower than on younger trees. Moreover the wounds were of considerable size and therefore would require several years before closing in completely.

Of the protective coverings used, avenarius carbolineum again caused the most serious injury. Where it had been applied, practically no new bark had been formed. The injury to the entire wound at the time of application had so enlarged the surface and had so weakened the surrounding tissues that there is doubt as to whether complete healing could ever occur. Only traces of a new callus showed here and there. In several cases a considerable strip of bark directly beneath the wound was killed. The untreated wounds on the trees where carbolineum had been applied were all making considerable growth. Wounds upon or nearest the trunk, especially those carefully made, were making the greatest growth. All of the unhealed surfaces, however, showed a cracking and checking due to drying out but upon none was there any indication of the entrance of a fungus.

All of the other materials heretofore mentioned caused greater or less injury. Yellow ochre, while not as injurious as carbolineum, caused considerable injury. Furthermore, the substance adhered poorly, leaving the surface of the wounds dried out, thus affording as easy an access for diseases as those not treated. Lead and zinc adhered well but caused considerable injury although the wounds were overcoming this set-back and closing in. The unhealed surfaces at this time were fully protected by a good coating of the paint. The coal tar was considerably absorbed but the wound surfaces were in good condition aside from the injury caused by the use of it. Manifestly, all of the coverings used except shellac had at first exerted a deleterious influence upon the formation of bark growth. Only two of the preparations, lead and zinc, adhered to the surfaces at all well. The others besides being injurious proved to be valueless as permanent dressings for pruning wounds. Lead or zinc, notwithstanding the initial injury caused, was the most valuable of all the materials for use on large wounds.

II. DELAYED TREATMENT OF PRUNING WOUNDS OF APPLE TREES.

Early in February, 1911, a number of dwarf apple trees eight years from setting were pruned. The last of March, after the cut wood had thoroughly dried out and the surface of the wood had become seasoned, dressings of yellow ochre, white lead and zinc, coal tar and shellac, were applied. Groups of six trees each were treated with the various dressings, two wounds on each tree being protected while two others were left untreated to serve as checks. None of the wounds exceeded two inches in diameter. Thick coatings of the materials were applied yet care was taken that the cut surfaces only should be covered. Observations at the end of the growing season of 1911 revealed a certain amount of new bark formation on all of the wounds. This new growth was greatest upon those treated with shellac and upon the check wounds. No difference was noticed in the amounts of new bark formed on the wounds of these two classes. Possibly the shellac had stimulated healing — certainly it had not been a retarding factor — but the differences in growth were so slight as to be negligible. Less growth was made on the wounds treated with the other materials. Many of the wounds had been enlarged at the base and but little new growth was made at this point. Those upon which ochre had been applied appeared to have suffered the most serious injury.

At the end of the next season, 1912, just before the trees were discarded, a final examination showed that many of the wounds were nearly closed in. The untreated wounds and those upon which shellac had been applied exhibited the greatest growth. Most of the shellac had crumbled away which resulted in the drying out of the unhealed surfaces. The injurious effects caused by the application of the other materials were overcome to a large extent by the formation of new bark, yet the healing on all of these was less advanced than on those which had received no treatment. Both the yellow ochre and coal tar were considerably impaired by weather conditions. The lead and zinc, however, remained intact.

It is a common supposition that dry wounds hold protective preparations more effectively than those freshly pruned but this fact was not substantiated. No differences could be found regarding the adhesive properties of the dressings whether applied to dry wounds or to those freshly cut. Nor did there appear to be any difference in the degree of injury or in the amount of new growth formed, between the wounds treated at once and those which were first allowed to dry out. There was no indication of fungus diseases attacking either the wounds treated or those left untreated. To be sure, all of the wounds were small and the length of time required for healing would be relatively short thereby lessening the chance of fungus attacks.

In this experiment it was plainly to be observed that the wounds upon the trunk and lower branches closed in more rapidly than those farther removed. Likewise the closer the wound was made to the axis of the stem, the more readily it healed. This was true in a lesser degree for the treated wounds than for those left bare.

Yellow ochre again proved to be the most injurious material used, with lead, zinc and coal tar closely following. It must not be thought that there was any vast difference in the amount of injury caused by these various substances. Such differences were slight — in fact often hardly to be estimated.

III. IMMEDIATE TREATMENT OF SPRING-PRUNING WOUNDS OF APPLE TREES.

The last of April, 1911, groups of five to eight dwarf apple trees each with from two to three wounds not exceeding two inches in diameter were treated with the same substances as in the last experiment. These dressings were applied immediately after the pruning, before the wounds were allowed to become dry. Other wounds upon each tree were left untreated to serve as checks. The effect of the treatment at this season of the year seemed to be not unlike that of similar dressings applied when tree growth was dormant. At the end of the growing season, 1911, all of the wounds showed some new callus growth. Nevertheless, all of the materials, except shellac, caused the same injuries noted in the other experiments. Most of the wounds had been enlarged and new bark had but slowly started. The untreated wounds presented more new growth than any of the others. Those treated with shellac were next in this respect. This material still remained intact over the wound surfaces.

The results noted at the end of the second year following the pruning were very similar to those obtained in previous trials. They can be summed up by saying that the untreated wounds presented the greatest amount of new growth, although closely followed by those upon which shellac had been applied. Yellow ochre had caused more injury to the tissues than the other materials, yet each of these in turn had produced some injury. No differences were noted between the adhesive qualities of the dressings applied in late spring and those used during the dormant season, nor were there differences in the relative amounts of new growth formed. Not in a single instance was there any indication of disease. As a whole the final outcome of this experiment was so nearly like that of the one last mentioned that further elaboration is unnecessary.

IV. IMMEDIATE TREATMENT OF WINTER-PRUNING WOUNDS OF PEACH TREES.

The first of March, 1912, a number of varieties of standard peach trees, five years from planting, were treated with materials identical with those used in the last two experiments, namely, yellow ochre, white lead, white zinc, shellac and coal tar. Groups of five trees, each with from three to four wounds, were treated with the various substances. Ten adjoining trees in the same orchard were also pruned and the wounds left untreated to serve as checks. None of the wounds made exceeded one and one-half inches in diameter and most of them were somewhat smaller. All of the trees were vigorous and thrifty and making a strong growth.

Observations showed, as the summer of 1912 advanced, that all of the materials except shellac were causing considerable injury. But little new callus was being made and a thick deposit of gum was becoming apparent over all of the wounds. This was less noticeable upon those wounds treated with shellac and rarely apparent on the untreated wounds. Such a result would clearly be indicative of severe injury to the cambium tissues due to the penetration of the various preparations. After the dormant period of the trees was reached, similar conditions existed — possibly more pronounced. Scarcely any new bark was observed on the treated wounds except on those covered with shellac, yet here there seemed to be increased gumming. The wounds protected by shellac had for the most part made considerable new growth but not as much as had those left untreated. The unhealed surfaces of these wounds were considerably seasoned yet they remained clear and free from any disease.

At the end of the following year, 1913, the untreated wounds and most of those upon which shellac had been applied had healed well. The majority of the untreated wounds were practically entirely closed in, especially those located upon the trunks and lower branches. A few still remained partially healed but none of these showed any indications of fungi. As a whole, however, these wounds and those treated with shellac showed very satisfactory results. An entirely different outcome was evident with the trees the wounds of which had been treated with ochre, lead, zinc and coal tar. Large amounts of gum covered nearly every wound. Little or no growth had taken place. The wounds had been enlarged and in a few instances there was doubt as to their ultimate ability to heal. All of the substances applied, excepting shellac, appeared to have equally injurious effects.

The inability of the peach trees to withstand and overcome such serious injury to their growing tissues as was caused by the several dressings was very evident. The increased gumming, a common occurrence on the wounds of this species of trees, was a manifestation of this injury. Inasmuch as the pruning wounds of peach trees, like those of all trees of this class, are relatively small and readily healed, the time spent in applying protective coverings is worse than wasted as it often results in injury.

CONCLUSIONS.

When one comes to deal with practices going back several hundred years, as does the covering of pruning wounds with protective dressings, care must be exercised in drawing conclusions. But from the results of this experiment several deductions seem quite warranted. First, the dressings commonly applied to pruning wounds retard rather than accelerate the healing of the wounds. Second, the effects are the same whether the dressings are applied when the wounds are made or some weeks later when the cut surface has dried out. Third, the effects of the dressings used are so injurious to peach wood that wounds on peach trees should never be covered. Probably this statement holds true for other stone fruits as well. Fourth, these experiments suggest that the popular notion that wounds need to be covered with some dressing to prevent the entrance of fungi, in sprayed orchards at least, is usually exaggerated. It is doubtful if it is necessary to attempt to prevent decay by applications of dressings of the kinds under discussion in wounds under four or five inches in diameter. It remains to be proved whether they have any real value in covering large wounds. It may be suspected that the injury caused by the dressings when applied to the wounds, largely, if not wholly, offsets, or even overbalances, the protection offered, if there be such, against decay.

DWARF APPLES.*

U. P. HEDRICK.

SUMMARY.

At the request of the horticultural societies of the State this Station undertook a comparative test of dwarf and standard apple trees. This bulletin is a final report of the test, which was carried on for ten years.

For the standard trees, French Crab stocks were used. For the dwarfs, Doucin and French Paradise stock.

Sites for the tests were selected with reference to climate and soil in three widely separated parts of the State as follows: Kinderhook, Columbia County, in the Hudson Valley; Fayetteville, Onondaga County, in central New York; and Carlton, Orleans County, on the shores of Lake Ontario, in western New York.

The general plan of the test was to grow a permanent orchard of standard trees with fillers on Doucin stock and between these trees on Paradise stock. The orchards were set with 27 varieties represented by 1193 trees; 114 were on French Crab, 424 on Doucin and 655 on Paradise stocks.

The care taken of the orchards was that commonly given commercial orchards in New York except in the matter of pruning. Summer pruning is part of the recognized yearly treatment of dwarf trees. In this ten years' test no satisfactory time nor method could be found to prune these trees which did not promote a weak, sickly growth. This invariably died back the next winter.

The results show:

1st.— That the union between stock and cion is poorer with Doucin and French Paradise stocks than with the French Crab and that varieties unite less well on French Paradise than on Doucin stocks.

2nd.— Doucin and French Paradise stocks are less hardy than French Crab, and of the two dwarfs French Paradise is much less hardy.

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3rd.— The greatest weakness of the dwarfing stock for New York is the surface-rooting habit, in which character the two stocks cannot be distinguished. Evil results following surface-rooting are winter-killing, uprooting of trees by wind, suckering and injury in cultivation.

4th.— Suckers from both dwarfing stocks proved much more troublesome than with the standard trees.

5th.— The trees on the three stocks attain the size commonly ascribed to them; those on French Crab are full sized; on Doucin, half dwarf; on French Paradise, true dwarfs. In this test the dwarfing effect of the dwarf stock was not as marked as is commonly reputed. We conclude that distances apart commonly recommended for dwarf trees bring them much too close; in New York Doucins should be set half and the true dwarfs one-third as far apart as standard trees. If the cion is permitted to strike root, greater distances must be allowed.

6th.— Trees on French Paradise come in bearing soonest, Doucin next and French Crab last. The differences in time of bearing would not be very material in commercial orchards.

7th.— The test has not been such that a safe conclusion can be drawn as to which stock makes the most productive orchard.

8th.— There were no marked differences in size, color and quality of the apples on the three stocks.

9th.— The advantages of dwarf trees appeal to amateur rather than professional apple growers. Thus, the trees take less space and therefore permit a greater variety in orchard or garden and they are handsomer ornamentals.

INTRODUCTION.

Especial interest in dwarf apples at the New York Agricultural Experiment Station began in 1901, when the State Fruit Growers' Association, The Eastern New York Horticultural Society, and the Western New York Horticultural Society appointed committees to confer with the authorities at the Station for the purpose of locating experimental orchards of dwarf apples. At this time the country was in one of the periodic revivals of interest in dwarf fruits which have several times held sway in eastern America. Nurserymen, the horticultural press and a number of prominent fruit growers were recommending the planting of dwarf trees. But there was a well-defined motive behind the movement which led the horticultural societies of New York and this Station to cooperate in the planting of dwarf apples.

San José scale had come into the State and was rapidly spreading. It was known that it could not be exterminated and it was feared that it could not be controlled. It was thought at that time that the scale could be best controlled by fumigating the trees under tents and it was believed that full grown standard trees could not be thoroughly sprayed. Since it was certain that dwarf trees could be easily fumigated and thoroughly sprayed, fruit growers asked for an experiment to determine whether dwarf apples could be grown profitably in commercial orchards. Had it not been for this apprehension of grievous disaster from San José scale, it is doubtful if the fruit growers would have called for the investigation, or the Station have voluntarily undertaken it.

While dwarf trees are by no means novelties in American fruit culture, yet there is a surprisingly large number of fruit growers who have misconceptions about them. What are dwarf trees? How is the dwarfing brought about? These questions must be answered before we can proceed to a rational discussion of the experiment in hand.

DWARF TREES.

Dwarf trees are plants which by various means are made to grow smaller than normal specimens of the same species or variety. In this instance the word " dwarf " does not carry with it an implication of unhealthiness or of weakened vitality. Animals and plants are so often dwarfed through disease or through lack of vitality that we associate the word with lack of health; but a dwarf tree may be as healthy and may have as much vitality as a normal tree, so that " diminutive trees," and " miniature trees," are rather more applicable than " dwarf trees ".

Fruit trees are dwarfed in several ways; as, by growing on stocks which dwarf the top, by restricting the root-run and by pruning to check or suppress the top. Horticulturally speaking, particularly as the term is applied to fruit trees, in America at least, dwarf trees are those which are grown on dwarfing stocks. Here, it may be remarked that tree-like forms usually succeed very well on bushes or smaller growing plants of the same species or, often, of closely related species. The cases are few, however, where varieties or species of small stature and port can be profitably grafted on plants of larger size. Unfortunately, there are no known relationships of plants which serve as accurate guides in the matter of grafting. The affinities of stocks and cions are determined only by trial, and so far there is a sad lack of systematically arranged experiments in this field of horticulture.

When dwarfing is produced by grafting on another stock, the tree takes on the size, and to some extent the habit, of the plant upon which it is grafted. Thus, the pear on quince takes the size of the quince tree; an apple on the bush-like Paradise, the size of this miniature apple tree; on the half-dwarf Doucin, an apple variety of normal size takes the form and habit of the Doucin. In none of these cases, as we have indicated before, is there a lessening of health or vigor.

Just how large-growing plants are dwarfed by grafting them on small-growing ones, is, as yet, not well determined. Undoubtedly, the lessened supply of food and moisture provided for the top of the tree by the smaller root-system of the dwarfing stock is one cause of dwarfing. This cause is suggested — indeed is almost established — by the fact that in a hungry or thirst-parched soil, dwarfed trees succumb much more quickly than those on roots of normal size for the plant. Probably another cause of dwarfing is the barrier which grafting imposes on the ascending and descending currents of plant food. True, such a barrier exists in all grafting, for a time at least, but in the case of the small or slow-growing stock the barrier is greater and more permanent. Assimilated food is prevented by this barrier from descending from the cion into the stock. This is shown by the enormous swellings just above the graft-union in many dwarf trees. The upper figure in Plate IV shows such a swelling in the case of a normal-growing variety of the apple grafted on Doucin, a dwarfing stock.

From what has been said one sees at once that in an experiment with dwarf fruit trees we are to be greatly concerned with dwarfing stocks. If space could be spared it would be profitable to discuss the whole subject of stocks as well as the closely related one of the reciprocal influence of stock and cion, but a full discussion of either subject would go to the length of a volume — as interesting as long. We cannot here attempt more than to discuss stocks for apples.

STOCKS FOR APPLES.

Nurserymen in Europe and America list and describe at least a dozen and perhaps a score of stocks upon which apples are worked. The more one studies the descriptions of these forms the more sceptical he becomes, however, of the distinctness of several of them and the more certain he is that with present knowledge we are all at sea as to what stocks we really have upon which to work apples. Until we have somewhere a careful test, side by side, of all apple stocks, an experiment best carried on in the Old World, we can only roughly throw apple stocks into two groups, standard and dwarfing stocks, in each of which are several more or less distinct forms.

Standard stocks.— What we in America call standard stocks, in England more commonly called free stocks, known also in both countries as Crab and French Crab stocks, are seedlings of the common apple, *Pyrus malus*. There is a mistaken notion in America that these stocks come from seeds of *Pyrus baccata*, or hybrids of it, which constitute our crab apples. It is doubtful if true crab seeds are often, if ever, planted for standard stocks. In Europe, crab stocks are those which come from wild apples, or trees which are escapes from cultivation; while stocks grown from the seeds of cultivated apples are called Free stocks. In America we make no such distinction. In fact until recent years all, or nearly all, standard stocks for this country were imported from France and Belgium under the name " French Crab " with the implication, too often given credence by nurserymen, that they were seedlings of true crabs.

There are, then, at least two kinds of standard stocks; those grown from seeds of wild apples and seedlings of cultivated varieties. Were choice possible, there should be no hesitation on the part of fruit growers to take seedlings from wild trees. It is difficult, however, to obtain seeds from wild trees and most of the apple stocks now used by nurserymen come from seeds taken from cider mills. Since all cultivated varieties of apples and crabs may go to the cider mill, the resulting seedlings cannot fail to be variable, giving good, bad and indifferent stocks. It is not strange that wide variations are to be found in individual trees of every variety of the apple, due, as we think, to stock and soil and not, except in rare cases, to inherent variation in varieties. We cannot leave this subject without expressing the opinion that one of the things most to be desired in apple growing is a vigorous standard stock of constant habit. Such a stock will probably have to be propagated from cuttings or layers.

The ancients, unquestionably, and fruit growers down through the Middle Ages, if they grafted at all, used standard stocks, taking such seedlings as circumstances placed at their disposal. Probably until comparatively recent times, a very great majority of fruiting apple trees were on their own roots — themselves seedlings. However, a study of Varo, Cato, Columella, Vergil and Pliny, sturdy Roman farmers and writers of and before the Christian era, shows that the art of grafting was well known to them and was practiced in growing apples as well as other fruits. Apple seeds were probably planted for stocks, then, two thousand and more years ago, though the nursery practices may not have been the same.

In America the general use of apple stocks did not begin until the Nineteenth Century. Colonists from the Old World brought apple seeds and not trees. Varieties of new fruits seem scarcely to be mentioned until after Revolutionary times. As settlements spread westward, apple seeds were planted though, if, when the seedlings reached fruiting age, the product was not desirable, the trees were grafted to sorts of better character. One or two nurseries existed before the Revolutionary war, but seedling apple trees to be kept for their own fruit or to be grafted over were the rule until well into the Nineteenth Century.

Dwarfing stocks.— Apples are dwarfed by grafting or budding them on small-growing forms of the cultivated species of this fruit. What are these species? Scarcely any two botanists who have studied the apple agree. Possibly the best authority we now have is C. K. Schneider, a German. He separates apples from pears, as do many modern botanists, putting them in the genus Malus.[1] In this genus Schneider puts three species, *Malus sylvestris* Miller, *M. pumila* Miller and *M. baccata* Borkhausen, which contribute to our edible apple flora. The last named, distinguished chiefly by its small fruits and caducous calyx, counts only in what we in America know as Crab apples. To the two former and their hybrids belong large-fruited, edible apples. Of the two species, *Malus pumila*, the *Pyrus malus* of Linnaeus, is far the more important in fruit growing. According to Schneider, the various species in which botanists have put the several dwarfing stocks are all identical with *Malus pumila*. Accepting this authority, then, we must look upon dwarfing stocks as diminutive forms of the species from which come most of our cultivated apples.

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[1] Schneider, C. K. Handbuch der Laubholzkunde 1:714-725. 1906.

This Station is in a region of many nurseries, many of them long-established. The writer, therefore, has exceptional opportunities to observe the seedlings used in nursery work. Not infrequently apple seedlings are not budded, or buds fail. Watching these hedge-rows of seedling apples, or much more often, a seedling tree, one finds that the variation in the size of the plants coming from miscellaneous seeds is considerable. Unquestionably, careful selection of the dwarfest forms of these seedling trees would give us dwarfing stocks similar to those now in common use. Unquestionably, too, the dwarf, or unproductive, or scraggly-growing trees of this or that variety to be found in many orchards owe these qualities to the stock and not the cion.

Though dwarfing stocks have been used for centuries, as we shall see, no one, botanist or horticulturist, has put well-made descriptions of them on record. About the year 1875 a collection of stocks for apples was grown, in a comparative test, at Chiswick, England. Eighteen supposedly distinct sorts, obtained from reliable sources, were compared. Several were found to be identical so that the number was reduced from eighteen to eight as follows: French Paradise, English Paradise, English Nonesuch, English Broad-leaved Paradise, Doucin, Dutch Paradise, Pommier Franc, and Crab. The last two are free-growing, or standard, stocks so that we are now concerned with but the first six. From European books we have compiled the following brief notes on these six stocks since they are the ones most commonly used in the Old World in dwarfing apples and include the stocks with which we are to be concerned in discussing the work of this experiment.

French Paradise.—This, the Pommier de Paradis of the French, is probably the dwarfest of the several stocks and has the reputation, ungrafted, of being the most precocious in bearing as it is also in season of blooming and fruiting. Grown to maturity, this apple is described as being very dwarf, compact in habit, productive and bearing very good, early autumn, dessert apples, golden-yellow in color with a reddish blush, and of a brisk, agreeable, acid flavor.

Independent of its value as a dwarfing stock it is said to be a useful orchard or garden plant. The derivation of the name is obvious — the forbidden fruit of which Adam and Eve ate.

European writers maintain that French Paradise is too tender and delicate to be used generally in orchard work and that its place is indoors in pots or for special situations in the garden as trained plants. The root system of this stock is small, fibrous, very close to the surface and takes hold of the soil so slightly that trees several years of age can easily be pulled by hand from the ground. The stocks may be propagated from cuttings but are more commonly grown from mound layers. In some quarters trees on this stock have the reputation of being short-lived and of producing fruits that run small as the trees come to full maturity. Undoubtedly there are several strains of French Paradise of which the best known are the Pigmy and Miniature stocks of Rivers. Some believe that French Paradise is the Dwarf Apple of Armenia.

Probably French Paradise is the oldest of dwarfing stocks for the apple. According to Koch, *Die Deutschen Obstgeholze*, 1876, French Paradise was known in France at the beginning of the Fifteenth Century at which time an account of it appeared in *De Natura Stirpium* by Jean de Ruelle. This stock was not in use in America until about the middle of the Nineteenth Century, when a plantation of dwarf trees was made by Ellwanger & Barry of Rochester, New York.

English Paradise.—This stock is often confused with the French Paradise from which it differs widely, being more vigorous, not so dwarf, and in having more woody and fewer fibrous roots. It is said to thrive on comparatively poor soils, whereas French Paradise must have a fairly fertile root-run. I can find no record of the origin of this stock. There is much to lead one to think that it is either a strain of, or is identical with, Doucin. As grown on the grounds of this Station it appears to be identical. It is not much used in America as a dwarfing stock.

English Broad-leaved Paradise.—This half-dwarf stock is hardly to be distinguished from the older and better-known Doucin but has a distinct origin having been raised from seed of the Nonesuch apple by Thomas Rivers, the noted English nurseryman, about 1820. It is a more vigorous stock than the English Nonesuch raised at the same time and from similar seed by Mr. Rivers. Occasionally one hears of this stock in America but here, as elsewhere, it seems to have been more or less confused with Doucin.

English Nonesuch.—This is a vigorous dwarf or half-dwarf stock raised by Thomas Rivers of Sawbridgeworth, England, from seed of the Nonesuch apple planted in 1820. It is the dwarfest of the English dwarfing stocks commonly used. According to Mr. Rivers it is "as dwarf but more hardy and vigorous than the French Paradise; it produces tufts of fibrous roots from every bud below ground, and it appears to be quite indifferent as to whether it will produce leaves or roots." This apple tree is peculiar, besides its dwarfness, in having very downy leaves and a much-knotted stem. It is said to stand transplanting particularly well. The differences between these dwarf seedlings of Nonesuch and the parent tree suggest that any surface-rooting seedling is more or less dwarf, a fact borne out by the observations of many. There are no records of the use of this stock in America.

Doucin.—The Doucin is a French stock which roots and grows much more freely than the French Paradise, the root-system differing greatly in having many more woody roots which strike downward to a greater depth. Many growers claim that there is little or no difference between this and the strong-growing Broad-leaved English Paradise — at least as nurserymen sell the two. Some say that Doucin can be distinguished from the Broad-leaved by a tap-root which the latter lacks. When permitted to bear fruit, the apples of Doucin are a greenish-yellow with a decided blush and are sweet — the flavor giving the name from the French "douceur" — sweetness.

It is hard to say how long the Doucin stock has been used, but at least it was well known in France and England in the middle of the Eighteenth Century for Duhamel du Monceau mentions it in his *Traité des Arbres Fruitiers*, 1768; as does Philip Miller in his *Gardener's Dictionary*, 1759. This is the chief dwarfing stock used in America, at least in name, for here all half-dwarfing stocks, as English Paradise and Broad-leaved Paradise, go as Doucin.

Dutch Paradise.— This is a clean, moderately vigorous stock somewhat intermediate between the dwarf French Paradise and the half-dwarf English stocks. It has the reputation of sending out suckers very freely — suckering so freely as often to be a nuisance in a garden. The plant, ungrafted, is low and scraggly, its habit having given it the name "Dutch Creeper." This is one of the old dwarfing stocks, Miller mentioning it in his *Gardener's Dictionary* in 1759 as follows: "There is another apple which is called the Dutch Paradise Apple, much cultivated in the nurseries for grafting Apples upon, in order to have them dwarfs; and these will not decay or canker as the other, nor do they stint the grafts near so much, so are generally preferred for planting Espaliers or Dwarfs, being easily kept within the Compass usually alloted to these trees." It seems never to have been introduced into America.

The origin of dwarfing stocks.— These few notes on stocks may give some fruit growers a better conception of what the several apple stocks are — their origin, introduction and uses. In particular, it is important to have in mind that they are but surface-rooting, dwarf plants of the common apple. We must get away from the notion that they come from distinct species. No doubt there are many true dwarf apples among the wild trees that are found wherever the apple has been cultivated long. No doubt, too, many of the small trees in standard orchards are on accidental dwarfing stocks. It is possible that the common apple is a hybrid, in some of its varieties at least, between a standard tree and a dwarf apple and that these miniature plants that occasionally appear are dwarf segregations. The fact that these surface-rooting dwarfs are easily propagated from cuttings and layers while standards are not, further indicates the distinctness of these strains even though they may occasionally come from the seeds of some variety normal in size of plant and manner of rooting. This brings us to a discussion of the propagation of dwarfing stocks.

Propagation of dwarfing stocks.— Some of the dwarfing stocks sucker so freely, as the Dutch Paradise, that the readiest means of propagation is to detach the sucker and use it as a stock. Some dwarfing stocks are propagated from root-cuttings. But, unquestionably, the chief method of propagation is by mound-layering. Well-established plants are made to stool by cutting them off a few inches from the ground. When these stools have made sufficient growth, usually in the summer of the second season, their bases are buried in a mound and by fall a rooted plant will have formed. These, if sufficiently vigorous, may be grafted the following winter or budded the next summer. The small stocks in a stool are grown in the nursery row for an additional year.

Occasion is taken to say that it would be a great boon to apple culture if standard trees could be propagated in some such manner and thus avoid the great variation in plants which we must always have in stocks grown from seed.

DISCUSSION OF THE EXPERIMENTS.

SITES AND SOILS.

Three sites were chosen for experiments: One at Kinderhook, Columbia County, in the Hudson Valley, on the farm of Edward Van Alstyne; another at Fayetteville, Onondaga County, on the farm of F. E. Dawley, and the third at Carlton, Orleans County, on the farm of Albert Wood & Son. The distribution of orchards in eastern, central and western New York gives quite distinct climatic and soil conditions for the three orchards. Topography and soil must now be described somewhat in detail.

The Van Alstyne orchard.— The village of Kinderhook, near which this orchard is located, is in the northeastern part of Columbia County, two or three miles east of the Hudson River. The orchard is about a mile south and east of the village on a level plateau about 100 feet above the Hudson which at this place is but a few feet higher than sea level. The land is sufficiently high and rolling to give good air drainage.

The soil is a sandy loam, rather deep, with a porous subsoil of the same sandy loam, considerably heavier but of such physical make up as to give very good natural drainage. A chemical analysis of this type of soil from an adjoining field shows it to be deficient in organic matter, nitrogen and lime, but amply supplied, for fruit crops, at least, with phosphorus and potassium. The land, though of but moderate productiveness for farm crops, is well adapted for apple culture, a fact at once patent to the passerby from the behavior of several neighboring orchards in approximately the same soil. Orcharding is the leading industry in the neighborhood.

The climate is ideal for the apple, falling short, if at all, only in the rainfall which is not always sufficient to supply the moisture needed by this fruit in the growing season in a soil not especially well adapted for the conservation of moisture. The apple, here, seldom or never suffers from winter temperatures; but peach wood is often killed back and the pear is occasionally injured by cold.

The Dawley orchard.— Fayetteville, the seat of the Dawley orchard, is east and a little south of Syracuse in the eastern part of

Onondaga County. The Dawley farm is rolling land on one of the high, level parts of which the dwarf orchard is planted, the lay of the land being such that the air drainage is very good as is, also, the water drainage in the somewhat open, stony land.

The land is a stony loam of the type designated by the United States Department of Agriculture as Miami stony loam. It is a brownish soil with some silt and some sand with an average depth of about 12 inches. The percentage of stone and gravel is large — possibly from 20 to 30 per ct. The subsoil, from one to three feet in thickness, is a clay loam or clay, more or less stony, and rests on limestone or shale. The soil is well supplied with phosphorus, potassium and lime but is somewhat lacking in organic matter. It is well adapted to the culture of general farm crops, alfalfa in particular, and apple trees thrive in it very well.

The winters in this region are cold, too cold for successful peach culture, and occasionally apples are injured. Of more importance is the rainfall which in this region is rather greater and somewhat better distributed throughout the growing season than in either of the other two orchards. Possibly, too, moisture is conserved better in the soil of this orchard than in the other two. At any rate, during the ten years the Station has maintained its experimental plantations, this orchard has suffered least from drouth.

The Wood orchard.—The Wood orchard is between two and three miles from the southern shore of Lake Ontario near the village of Carlton in the north-central part of Orleans County. The Wood farm is on one of the level plains a half-hundred or more feet above Lake Ontario and between three and four hundred feet above sea level. The farm, though level, the orchard land almost dead level, is naturally well drained and winds from the lake keep the air sufficiently on the move to give good air drainage.

The soil is widely different from that of the other two orchards under test. It belongs to the Dunkirk series and is a sandy, silty loam, dark brown or grayish in color and a foot deep, underlain with a yellowish, heavy silt loam from two to three feet deep, under which, in its turn, is a very heavy silt loam. This land, as in the case of the other two orchards, is deficient in organic matter but well supplied with potassium and phosphorus. Grain crops usually respond to lime though leguminous cover-crops grow very well in the dwarf orchard without liming. This soil is especially well adapted for apples, the neighborhood, and more particularly the Wood farm, being unsurpassed in the State for crops of apples.

The climate of this region permits the culture of all hardy fruits. The water of Lake Ontario, from 10 to 15 degrees warmer in winter and cooler in summer than the air, gives a most equable climate. The mean annual precipitation is about 35 inches of which 9 inches falls during the growing months of June, July and August—too little unless high cultivation is practiced to conserve the moisture.

PLAN OF THE TESTS.

These tests were planned in 1902 by Professor S. A. Beach, then of this Station. The Wood orchard was set in the autumn of 1903, the Dawley and Van Alstyne orchards in the autumn of 1904. The following year, 1905, the present writer took charge of the horticultural work at the Geneva Station. This test, planned by Beach, has, therefore, been carried on for nine of the ten years of the life of the experiment by the author of this bulletin.

Briefly stated, the general plan of the three experiments was to grow a permanent orchard of standard trees with fillers of varieties on Doucin stock and between these fillers on Paradise stock. The distance between trees in the Wood orchard is fifteen feet; in the other two, twelve feet.

The Van Alstyne orchard was planted to 306 trees on the three stocks as follows: Standard trees, 27; on Doucin stock, 153 trees; on Paradise, 126. These were distributed among the following varieties: Baldwin, Boiken, Holland Pippin, Hubbardston, Jonathan, Lady, McIntosh, R. I. Greening, Rome, Sutton, Wealthy and Wagener.

The Dawley orchard was planted with 512 trees, the number on each stock being: Standard, 42; Doucin, 161; Paradise, 309. The following are the varieties: Alexander, Baldwin, Boiken, Esopus, Gravenstein, Green Sweet, Grimes, Hubbardston, Jacob Sweet, Jonathan, Longfield, McIntosh, Monmouth, Northern Spy, Pumpkin Sweet, R. I. Greening, Rome, Sutton, Wagener, Wealthy, Wolf River, Yellow Transparent.

In the Wood orchard there were originally 375 trees: 45 on standard, 110 on Doucin and 220 on Paradise stocks, distributed among the varieties Alexander, Baldwin, Ben Davis, Boiken, Gravenstein, Holland Winter, Jonathan, Lady, McIntosh, Monmouth, R. I. Greening, Rome, Sutton, Bismark, Twenty Ounce and Wealthy.

The stocks, with a very few exceptions, were purchased from Louis Leroy, Angers, France, and were French Crab for the standards, Doucin and French Paradise for the dwarfs. Later, to fill vacancies, a few trees worked on Doucin and English Paradise were used from a purchase of these stocks made from Wm. Fell, Hexham, England. The trees were budded on the Station grounds and were set, in the case of the Wood orchard, at one year from the bud and in the other two orchards, two years from the bud. A few trees were purchased from local nurseries to fill vacancies, but these have all been discarded in studying the results.

CARE OF THE ORCHARDS.

The three orchards received the care commonly given commercial orchards in New York except in particulars to be mentioned.

Cultivation.— The trees were usually given clean cultivation until August first, or thereabouts, and then a cover-crop was put in to turn under in fall or spring as the case demanded. For most part leguminous cover crops were sown, but the condition of the trees in several instances indicated a non-leguminous crop and in one or two seasons the crop failed to catch or could not be planted. The trees were sprayed for the several pests common to the apple as required. Full details of care in cultivation and spraying need not be discussed.

Cion-roots and suckers.— Beginning with the first year it was found necessary to go over the orchards each spring and cut such roots as sprung from the cion and such suckers as came from the stocks. This was no small task, the first operation requiring that more or less earth be removed and replaced. It may be said that the trees should not have been set so deep as to make this necessary. Shallow planting was tried in the Dawley and Van Alstyne orchards but with disastrous results with the surface-rooting Doucin and Paradise trees, many of which were blown over with even moderate winds; others suffered from sun, plow and cultivation. It was found necessary to hill up these shallow-rooted trees by plowing toward the rows.

Pruning.— We may as well confess that the pruning of these trees has been most unsatisfactory. A bad start was made, as the trees, for most part, were cut to whips at transplanting time. (See Plate XL.) No doubt, in the light of later experience, it would have been better to grow the trees in nursery rows a year longer and then make the start toward forming the heads. The trouble in cutting to a whip at transplanting time is that branches fail to break forth as abundantly as they do in the nursery row unchecked by transplanting.

Summer pruning, supplementing winter pruning, is part of the recognized yearly treatment of dwarf trees. The more it is desired to restrict the growth, the greater the need of summer pruning and the greater the amount necessary. There is, however, much divergence of opinion as to methods in summer pruning. Scarcely any two authorities on growing dwarf trees agree as to the amount of wood to be taken out or the proper time to do the work. Some growers use the knife and shears, while others say that pinching back with finger and thumb suffices. All agree that the practice must be largely regulated by season, soil, health of tree, age of tree and the variety. The difficulties in the way of laying down rules that would be fair in this comparative test of twenty-six varieties of apples on three stocks, three quite distinct soils and in three somewhat different climates, are patent to any one who has tried to prune in the summer.

The winter pruning of the trees, though more difficult than in training standard trees, gave comparatively little trouble. It consisted of cutting out crossed branches, surplus branches and, of course, such few as were injured or diseased. It was necessary to head back the wood on the Paradise and Doucin trees more severely, depending upon the variety, than the standards, otherwise the pruning was much the same on all. (Plates XLI and XLII show the method of pruning in the winter.)

For the first two seasons but little summer pruning was attempted, the trees being small and none too vigorous. Then began a series of experiments, no one of which proved satisfactory, the details of which belong to a separate bulletin. Suffice to say, in the light of ten seasons' work with dwarf apples, the training of the plants is the most difficult and the least satisfactory operation in growing these trees. Indeed, it is hardly too much to say that if dwarf apples must be headed back or pinched in during the growing season, it is impossible to grow them in the trying climate of New York. In no one of the attempts at summer pruning have we been able wholly to avoid weak, spindling second growths which would not mature

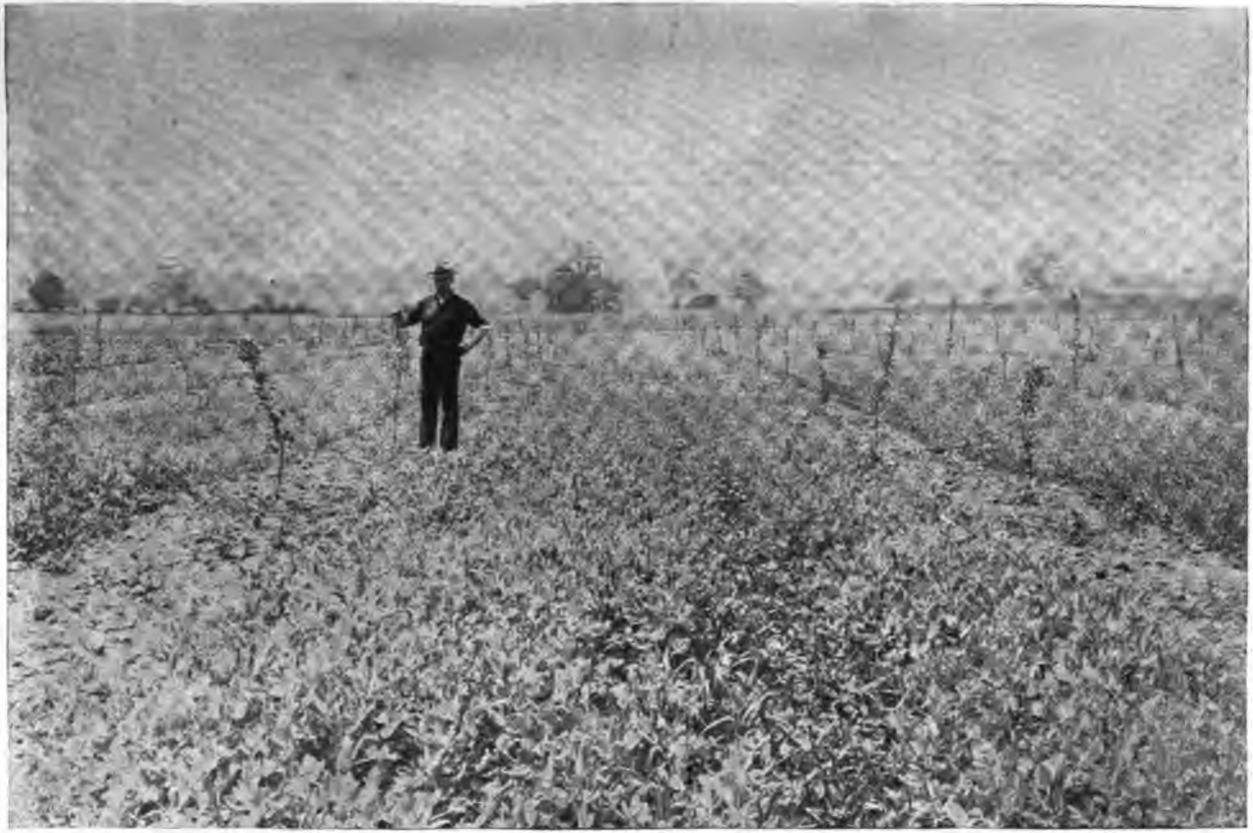


PLATE XL.—VAN ALSTYNE ORCHARD: MANNER OF PRUNING AT TRANSPLANTING.

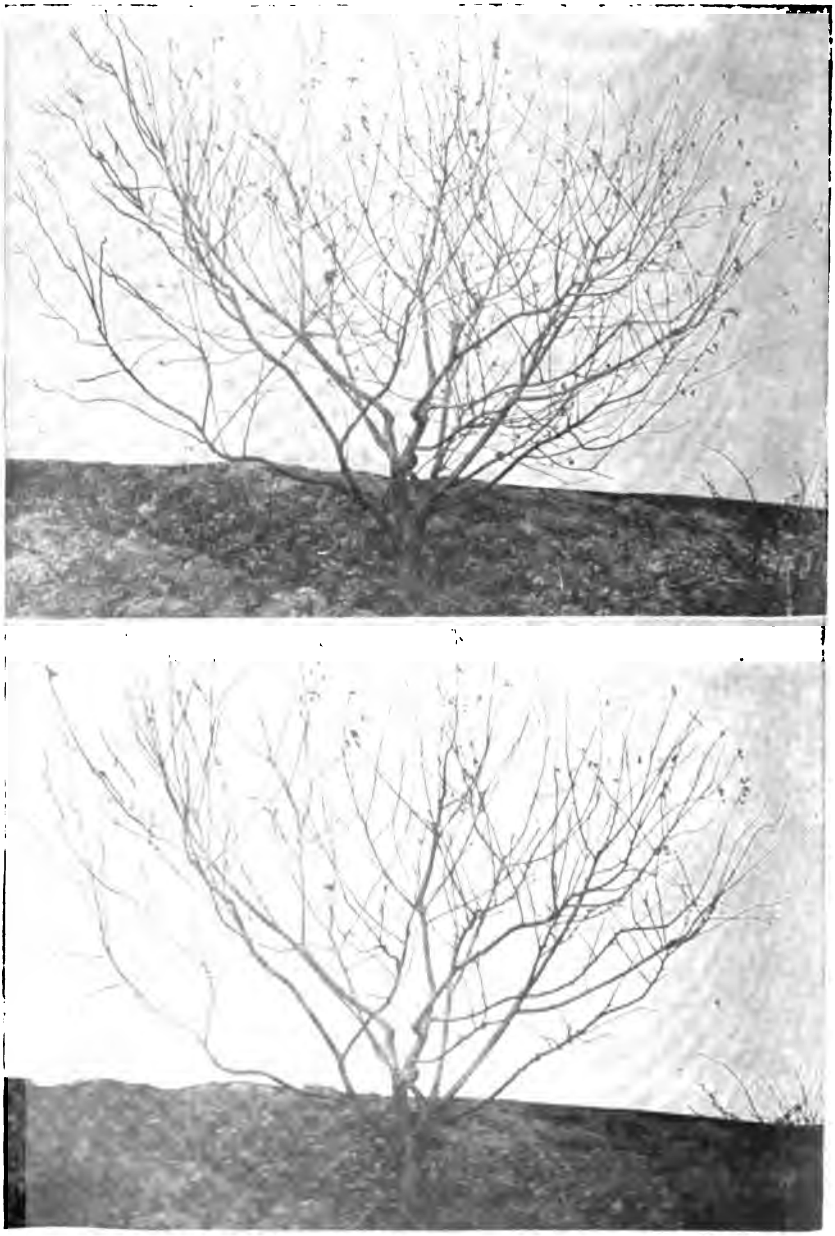


Plate XLI.— Tree on Doucin Stock Before and After Pruning.

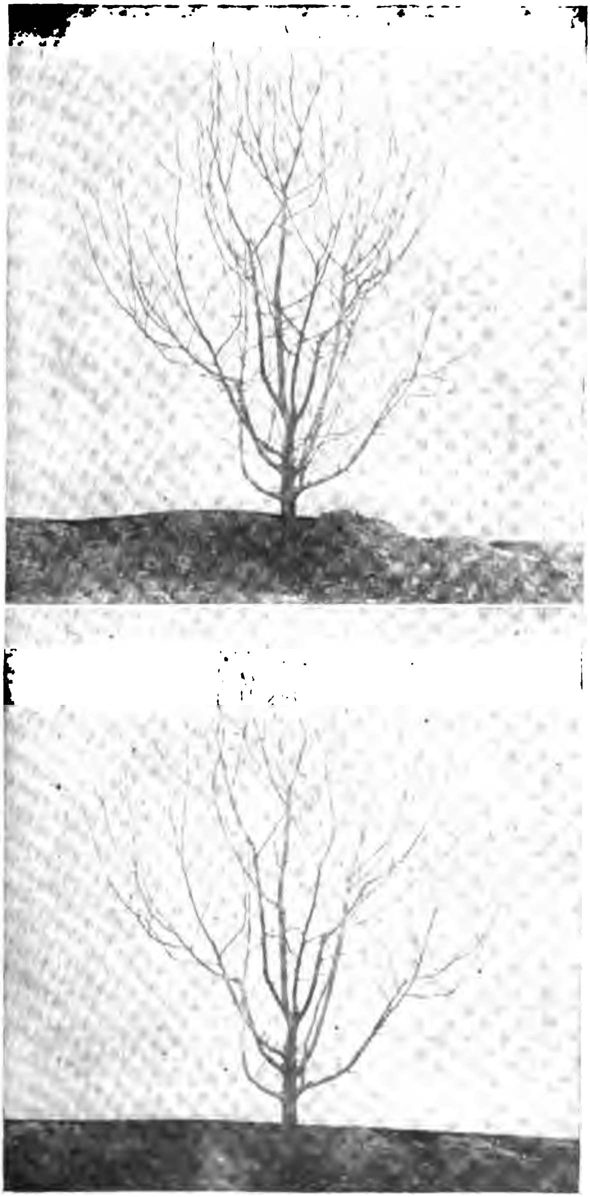
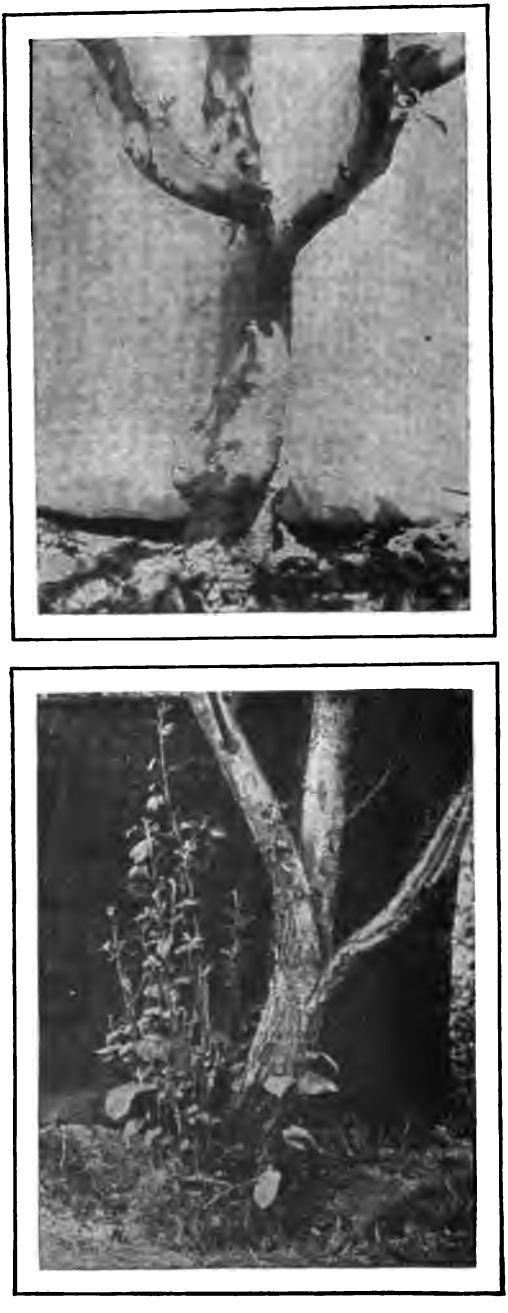


Plate XLII.— Tree on Paradise Stock Before and After Pruning.



XLIII.— Defects of Trees on Doucin Stock; Upper, Protuberance Above Union; Lower, Suckering Habit.

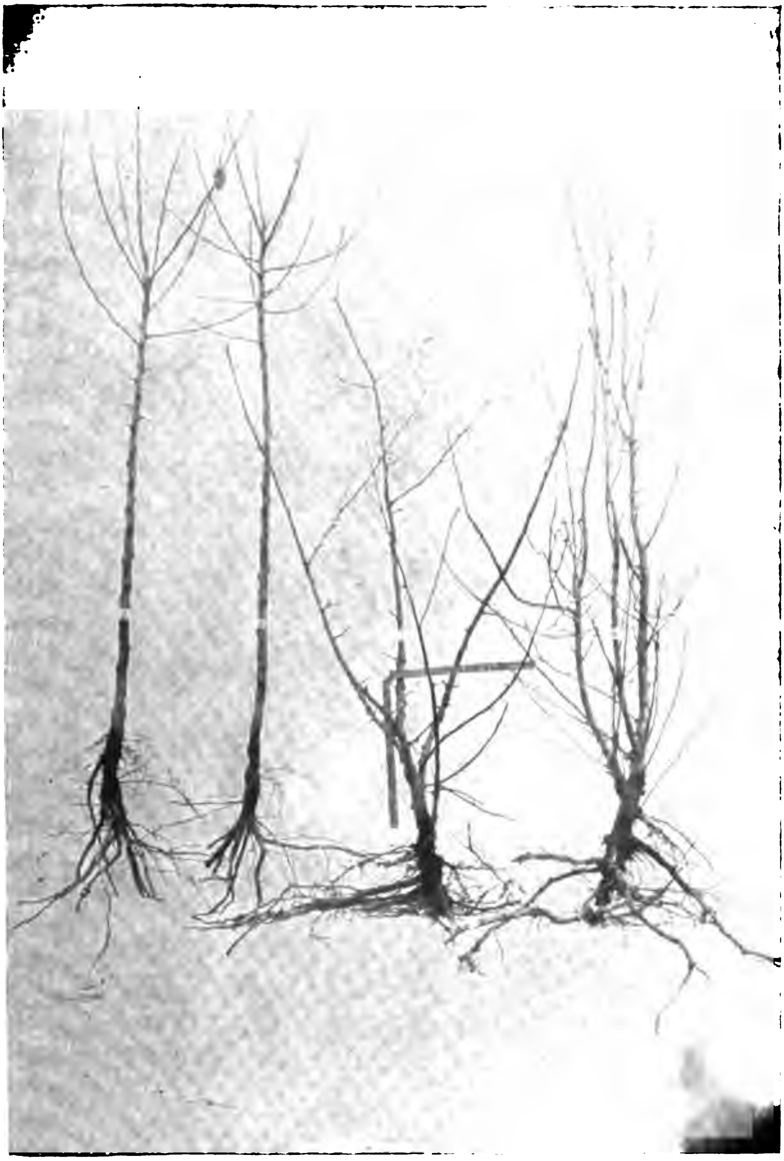


Plate XLIV.— Root Systems of Apple Trees: Left, Budded Standard; Second, Grafted Standard; Third, Paradise; Right, Doucin.

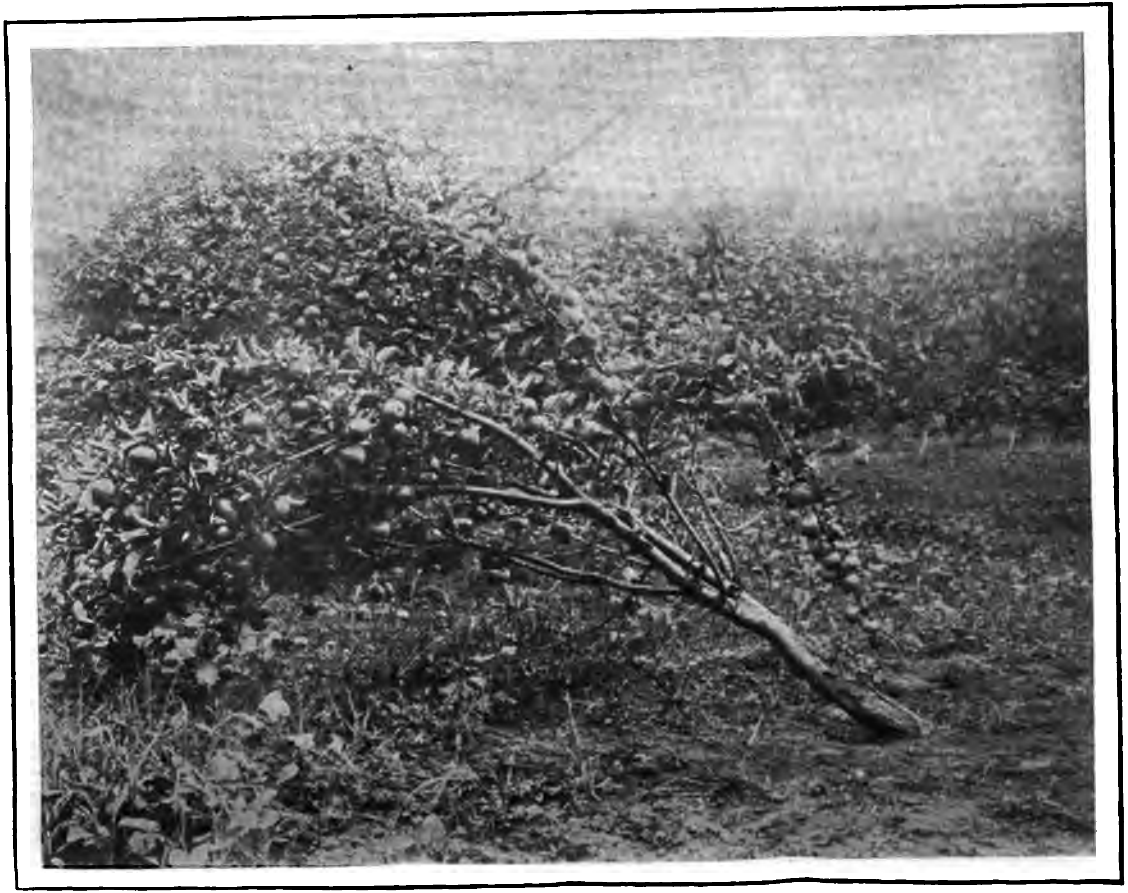


Plate XLV. - Wagener Apple Trees on Paradise Stock Blown Over, Ten Years from Setting

Plate XLVI.— Wood Orchard: Trees on French Crab, Doucin and Paradise Stocks.

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and succumbed to the cold of the next winter. When it was thought that reasonable success in time and manner of summer pruning had been attained one season, sooner or later identical treatment proved a failure because of some decided difference in weather when the work was repeated. We have been forced to conclude that the great variations in temperature and moisture in the summer and the cold winters in New York almost or quite debar the summer pruning here that is practiced in the Old World.

Mishaps.— The three orchards have had the usual mishaps, expected and unexpected, common to apple culture. A few trees did not start growth, several were girdled by mice, a loose colt destroyed one, sheep injured several, apple-blight took its toll and a few sickly, unhappy specimens for no apparent reason refused to thrive and were pulled out. Yet out of the total of 1118 trees the percentage of loss was comparatively small from the causes mentioned, but from three other sources of trouble the number of missing or replaced trees at the end of the experiment was large, quite too great for profitable orcharding. A surprisingly large number of trees were winter-killed; many failed to make a good union, with death or failure as a result; and the surface rooting habit of the dwarf trees caused an unexpected number of deaths and failures. These three troubles must later be discussed in detail.

MEASURING THE RESULTS.

It would seem that the efforts expended and the money spent in this ten-year test of dwarf and standard apples should give decisive results. But the conclusions that can be drawn are far from final. In the first place we have not learned in the test, long as it was, how best to care for dwarfs, especially in the matter of summer pruning and in preventing the disastrous surface rooting. Then, again, we are not able comprehensively to compare yields from the three stocks; and crops of fruit are, of course, the ultimate criteria. Trees one year old at setting and ten years set are not bearing sufficiently well to gauge productiveness, especially when it is remembered that varieties on the three stocks begin bearing at different ages. The many mishaps, too, especially the winter-killing the first two years, help to prevent decisive results.

The men who own the trees, those who have carried on the test and the many apple growers in the State who have annually or occasionally visited the orchards, all agree that dwarf apples should not be planted in commercial plantations. This conclusion is forced by the behavior of trees in general rather than by specific things that can be set down in a bulletin in exact statements and tables of figures. From the nature of this test with its many factors and present incompleteness, reliance will have to be placed upon statements of opinions.

The union of stocks and cions.— The value of a stock is greatly reduced if the union between the consorting parts of the tree is poor. There is no question but that varieties unite unequally well with different stocks. The point is well worth establishing as to which varieties make the best unions with the three distinct stocks used in this test; but, unfortunately, the data are not conclusive enough to make a critical analysis. There were not enough cases in which one could unhesitatingly say that death or failure was wholly due to a poor union.

The following figures, however, show conclusively with which stock apples, irrespective of variety, unite best: thirty-one trees on Paradise are reported to have broken off at the union during the ten years' test; four on Doucin; none on French Crab. There were, too, a considerable number of trees in which there were enlargements above the union as shown in the upper half of Plate XLIII. These, however, seem to affect the vigor of the tree little or not at all. There were no enlargements on standard trees in this test though they may occasionally be seen in orchards of standards. The number of these deformities on the two dwarfing stocks seems to be about the same though it is impossible to give the exact number since one can hardly say when an enlargement at the union becomes abnormal. These figures seem to indicate that the union between stock and cion is poorest on the Paradise, next so on Doucin and best on the standard.

Winter-injury.— It is impossible to discuss hardiness of the three stocks comprehensively in this Bulletin. To do so would carry us far afield since the three orchards have quite different climatic conditions and there are twenty-seven varieties of unequal hardiness. The following figures, grouped for the three orchards and roughly given, seem sufficiently accurate to indicate the relative hardiness of the three stocks.

Of the 600 trees on French Paradise, 57, or 9.5 per ct., are marked as having died of winter-injury; of the 404 Doucins, 18, or 4.45 per ct., were winter-killed; on the French Crab but 3, or 2.75 per ct. succumbed to cold. Of course one can seldom be quite certain as to what causes the death of trees but in these orchards when there was reasonable doubt the cause of death was put down as "unknown." The figures given, are, in the judgment of the writer, much strengthened by the facts that the numbers of dead trees from causes "unknown" run in about the same proportion for the three stocks and that some of the dead trees had suffered from previous winter-injury.

That the dwarfing stocks are less hardy than the French Crab occasions little surprise when one remembers that their roots are much nearer the surface of the ground. The French Paradise is reported everywhere in Europe to be tender to cold and it is to be expected that it would be less hardy in the trying climate of New York than either of the other two stocks. Most of the deaths from winter-injury occurred in the Dawley and Van Alstyne orchards, where, it will be recalled from the descriptions given, the cold is more severe than in the Wood plantation.

Undoubtedly the injury from winter-killing was more severe the first and second seasons because of the trees having been planted in the autumn. From the experience with fall planting in these three orchards, it may be laid down as a rule that dwarf trees should not be planted in the autumn in a climate as cold as that of New York.

Surface-rooting.— Without any question the greatest weakness of dwarfing stocks for New York orchard conditions is the surface-rooting habit of both Doucin and Paradise. In this respect the two stocks cannot be distinguished — the roots of one are as near the surface as those of the other. Plate XLIV shows the rooting habit of the three stocks. Several evils follow surface-rooting. We have seen in a previous paragraph that the dwarf trees suffered most from winter-injury — no doubt in part because of the nearness of the roots to the surface. In respect to yield of fruit and size of tree, the results in this experiment are almost worthless because of another trouble which comes from the roots being too close to the surface of the ground.

About ten per ct. of the dwarf trees in the three orchards, sooner or later, either blew over or their roots were so exposed that the trees had to be reset or replaced. Plate XLV shows a tree on Paradise blown over the last year of the experiment. Such trees are out of the experiment so far as tree-growth and yield of fruit are concerned. Undoubtedly, too, some of the trees that refused to thrive did so because of the exposed condition of their roots. In a damper climate, in sod or under a mulch system, surface rooting might not prove so disastrous. This experiment all but demonstrates that dwarf apples can not be successfully grown under the high cultivation methods of New York. It may be asked why the trees were not set deeper. The answer is that if the trees be set sufficiently deep so that the cion touches ground it strikes root and the tree ceases to be a true dwarf. Many trees that pass for dwarfs are not dwarfs at all. They were set on dwarf stocks but the cion has taken root and the tree has become a standard, or, more correctly, half standard and half dwarf.

The several dwarfing stocks are surface-rooting plants, according to all accounts, but it is probable that this fault is accentuated by the manner of propagation. Plants grown from cuttings and layers usually fail to produce the tap-roots and the deep-growing root systems that most seedlings have. This is a matter that would need consideration in any attempt to grow standard stocks from cuttings — a method with many advantages in eliminating variability from orchard trees.

No doubt, too, much of the suckering of the dwarfs which so vexed the souls of the experimenters came from root wounds made by the plow or cultivator. This brings us to the matter of suckering.

Suckering.— Suckers from both of the dwarfing stocks proved more or less troublesome. It would be hard to say whether Doucin or Paradise suckered most, but the weight of evidence seems to be against the Doucin. Both stocks are readily propagated from layers and stolons, either roots or stems striking root freely. It would, then, be expected that suckers would appear more freely than on standard stocks which come from seed and can be grown vegetatively only with difficulty. Presumably, however, there would have been far fewer suckers to contend with in these orchards under a sod or a mulch system of cultivation, for certainly the unavoidable injury to the shallow roots of the dwarf trees by plow and cultivator would stimulate the formation of suckers. The lower half of Plate XLIII shows the suckering habit of the Doucin stock.

The size of the trees.— What is the comparative size of varieties on the three stocks? It would seem that by giving figures of height and spread of tree and diameter of trunk the question could be easily and accurately answered. Not so; such figures are distinctly misleading. Could the reader see the trees, eye-sight would be much better than figures to show the size of tree. The eye sees a distinct difference in varieties on the three stocks which figures do not show, for the reason that the difference is in habit of growth quite as much or more than in size. Thus, the Paradise trees are dwarf because of a very short trunk, the diameter of which is often nearly that of a Doucin or Standard; the shoots of Paradise spring up to an amazing height from a dwarf frame-work so that figures make the trees seem unduly high. So, too, the slenderer and more straggling growth of the Doucin trees magnifies the height and spread of trees on this stock if figures be followed closely. The photograph reproduced in Plate XLVI gives a much better idea of the size and habit of the trees than would figures. It shows that a tree worked on Paradise is not only dwarfed but takes on the habit of growth of the Paradise; on the Doucin, the habit of Doucin; on French Crab, the habit of the Crab. It shows, too, what we have been taught, that true dwarfs grow on Paradise and half-dwarfs on Doucin.

We must, however, state disappointment in the dwarfing effects of the two stocks. There is not nearly the difference in size that we had expected between trees on the three different roots. No doubt, the failure to find a workable method of summer pruning had much to do with the vigorous growth of the dwarfs. It is certain that man must aid the stock very materially in dwarfing trees by severe pruning and training in both winter and summer. It is to be feared, despite efforts to prevent it, that some of our trees took root from the cion and so added to their size.

A glance at the photographs shows that both Paradise and Doucin trees must have far more room as the trees grow in New York than is commonly recommended for them by either European or American writers. The distances recommended for Paradise range from six to twelve feet and from eight to sixteen feet for Doucin. From experience with the trees in these experiments, but more particularly judging from an orchard of trees on Paradise and Doucin at the Station, much older than the trees under discussion, we should say that in cultivated orchards, apples on Paradise should be planted from fifteen to eighteen feet apart; on Doucin twenty to twenty-five feet, depending upon soil and variety. This means that in this State where standards are set from forty to fifty feet apart, Paradise should be set one-third and Doucin one-half as far as standards. On poorer soils, in sod and where heavy summer pruning can be practiced, lesser distances may suffice.

Fruit-bearing on the three stocks.— The measure of the value of a stock is, of course, the yield of fruit. Hardly less important in this test, at any rate, is the time the varieties came into bearing since one of the chief virtues of dwarfing stocks is to bring the variety grafted on them into early bearing. Still another point which the fruit grower wants settled is how different varieties respond in crop bearing on the three stocks. We come now to a discussion of these questions.

Yield of fruit.— The figures showing yield of fruit are not of much value. The crops were not harvested nor the amounts of fruit taken by men from the Station. Mistakes and omissions have been detected. Even had there been no mistakes, figures taken at this time would hardly be fair as to the amount of fruit borne on the three different stocks; for, as we have pointed out, the orchards were set on a filler plan which gives more than twice as many trees on Paradise as on Doucin and more than three times as many on Doucin as on French Crab. Then, too, the trees have suffered unequally from winter-killing, shallow-rooting and other troubles, as has been shown. The figures indicate, then, only approximately what commercial orchards on the three stocks will bear in the first ten years of their existence — trees set at one and two years from the bud. Since the three orchards are on quite different soils and grown in very distinct climates, each plantation must be considered by itself.

The Van Alstyne orchard was slow in coming in bearing, none of the trees yielding fruit until 1907, the third year from setting, when one fruit was borne on a standard tree, and three on a Doucin. In 1908 trees on all three stocks bore, but on no stock was there an average of an apple per tree; in 1909, 27 French Crab trees bore 28 apples; 135 Doucin, 246 fruits; and 100 trees on Paradise bore 175 specimens. In 1910 the crop was a failure and the few fruits were not counted. The first yield of fruit worth taking into account, then, was borne in 1911, trees 9 years from the bud and 7 from setting. The yields per tree for 1911 and the three remaining years of the test are shown in Table I.

TABLE I.— YIELDS IN VAN ALSTYNE DWARF APPLE ORCHARD.

Number of trees.	Stock.	YIELD PER TREE.			
		1911.	1912.	1913.	1914.
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
27	Crab	13	18	37½	79⅞
135	Doucin	10	21½	23	79
100	Paradise	7	15	14	36

The Dawley orchard bore its first fruit in 1906 when there were 83 apples on 300 Paradise trees, 23 on 157 Doucin trees and none on the 37 standards. In 1907 the Paradise trees, bore 96 apples and the Doucins 13, standards none. In 1908 there were 567 apples on Paradise, 224 on the Doucin and 7 on the standard trees. In 1909 the Paradise trees averaged about 2 apples to the tree, the Doucin 4 and the standards less than an apple. The 1910 crop was almost a total failure and it was not until 1911 that the yield could be taken in pounds, the averages per tree for the next four years running as is shown in Table II.

TABLE II.— YIELDS IN DAWLEY DWARF APPLE ORCHARD.

Number of trees.	Stock.	YIELD PER TREE.			
		1911.	1912.	1913.	1914.
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
37	Crab	3	3	0	81
157	Doucin	5½	17½	2	51
300	Paradise	5⅓	16	⅓	70

In the Wood orchard, 1 apple was borne on a Boiken on Paradise the first year set. The second year, 1906, the trees on Paradise bore 180 specimens on 192 trees, the Doucin 9 on 100 trees, while none of the 42 trees on French Crab bore. In 1907 the Paradise trees produced an average of a little over 4 apples per tree, the Doucin 2 apples per tree, while the 42 French Crabs bore 26 fruits. In 1908 the yield came up to 14 apples per tree on Paradise, 4 apples for each tree on Doucin and, all told, 17 apples on Crab. The yield in 1909 on Paradise was 30 apples per tree; on Doucin, 14 specimens; on French Crab but 18 apples for the 42 trees. As in the other two orchards the 1910 crop was a failure. Table III shows the yields per tree for the three remaining years of the test.

TABLE III.— YIELDS IN WOOD DWARF APPLE ORCHARD.

Number of trees.	Stock.	YIELD PER TREE.		
		1911.	1912.	1913.
		Lbs.	*Lbs.*	*Lbs.*
42	Crab	4½	13	39
100	Doucin	27	14½	61
192	Paradise	27	18½	50

Before comparing the yields for the three stocks we must first account for the tardiness with which the trees came in bearing and the small yield for the ten-year period. No doubt the excessive pruning to which the trees have been subjected in order to form good heads and the experiments in summer pruning have retarded bearing and kept the yield low. It must be remembered, too, that the trees were cut back to whips at planting. Several late-bearing sorts, two of which, Northern Spy and Sutton, are not yet in bearing, have made the average time of coming in bearing late and reduced the average yield. The last statement would be made plain if space permitted the publication of tabular data for the varieties and trees.

As the figures stand, the honors for productiveness seem to lie between the French Crab and Doucin trees. If we calculate the number of trees per acre for the different stocks, however, allowing the smaller distances between trees for the dwarfs, then the Paradise, per acre unit, is most productive for this first ten years, Doucin next and French Crab last. So many exceptions could rightly be made to such a calculation that it is not worth making. Those who have had to do with the experiment have been surprised at the comparatively small yield of the trees on Paradise. Few, indeed, are the Paradise trees that have been bent to the ground with a load of fruit as they are so often depicted.

Again we caution readers against drawing sweeping conclusions from these figures. The trees on all three stocks are just coming into commercial bearing and, as every fruit grower knows, the idiosyncrasies of trees coming in bearing are too many and varied to make data from them very reliable.

Time of bearing.— In considering age of bearing, it is important to keep in mind the age of the plants. Trees were budded for these experimental orchards in the summer of 1902. The Wood orchard was set in the autumn of 1903 and the other two orchards a year later. As has been recorded, a considerable number of the trees, especially on Paradise, were lost the first and second winters through injury from cold. Most of these were replaced from a reserve supply budded in 1902; a few, however, were purchased from nurserymen and except in one or two instances were of the same age. Trees set later than 1906 and those budded on our grounds after 1902, have been discarded. What are the facts as to the earlier bearing of dwarfing stocks?

In all three of the orchards, as the figures given show, the Paradise trees came in bearing soonest. But in no one of the three orchards was there what could be called a commercial crop on any of the stocks until the tenth year after setting, when, if we take an average of the three orchards, the trees on French Crab bore 66.5 pounds each; on Doucin 63.65 pounds; and on Paradise 52 pounds. The figures must be thus roughly combined or else given in detail at a length of several pages of tabular matter, in either case the showing being much the same; namely, that the dwarfing stocks bring apples into commercial bearing somewhat earlier than do crabs.

These figures, we hasten to say, are hardly fair to the dwarfing stocks. No question but that the orchard conditions in this test have been better suited to the standard trees so that both in the matter of yield and in time of coming in bearing the figures favor the French Crab stock. On the other hand, there is no question but that the eye always favors the dwarf trees. One sees dwarf trees loaded with fruit and jumps to the conclusion that they have come in bearing earlier and are more productive than the larger standard trees which cold figures show to bear more fruit, either per tree or per acre, but not so apparent to the eye. Dwarfs are much more spectacular than standard trees — hence, in part, their reputation for early and productive bearing.

It is interesting to confirm the expectation that varieties which come in bearing early on standard trees would behave the same on Doucin and Paradise. In the three orchards, varieties maintained very closely the relative time for bearing on the three stocks. Thus, Boiken, Bismarck, Alexander, Wealthy, Wagener, Wolf River, Ben Davis, Yellow Transparent and Rome are the early bearers on the dwarfs as we have long known them to be on standards; while Northern Spy, Sutton and Lady are, as on the larger trees, very late in coming in bearing, with Baldwin, R. I. Greening, Jonathan, Esopus, Grimes, McIntosh and Hubbardston in their usual place in the procession that varieties form in coming in bearing on standards.

Size, color and quality of apples on the three stocks.— From a commercial standpoint, and this is a test of commercial plantings, the results as to effects of the three stocks on size, color and quality, are, in a word, nil. There were, it is true, individual trees on Paradise and Doucin that bore particularly large apples and others that produced a handsomely colored crop, but when the product of all the trees of a variety was compared one had to declare that the fruit on one stock was quite as large and attractive as that on either of the other two. Nor was there any difference in the flavor of the apples from the three stocks.

Statements, so far as the apple is concerned, at least, that the product of dwarf trees is larger and better colored arise largely from two facts. As one compares the fruit of a variety on a dwarf and a standard tree, that on the small tree, being closer to the eye and more strikingly contrasted with the foliage, makes a better appearance. When the fruit is picked and compared, usually there is no difference. Again, dwarf trees are commonly pruned more severely, the crop thinned and the trees, all in all, given better care, which, of course, makes a far more attractive crop than the less well-cared for standards produce. Grown under as nearly identical conditions as possible, as in the care of these trees, it is doubtful whether there is much difference in the product of the trees on the three stocks.

The statements just made hold only for the apple in the gross — for the whole crop. Had the experimental orchards been near the Station, or the conditions such that a more careful study could have been made, it is possible that some generalizations could have been made as to the influence of the three stocks on size, color and quality. Certain it is that there are slight differences in ripening dates and, as all know, a difference in time of maturity usually means more or less difference in size and color. Any study of this kind, and such a study is much needed, must be made in tests where all conditions are more uniform.

"*What varieties do best on the dwarfing stocks*"? — Every fruit grower going into the test orchards asked this question. A little consideration shows that it can be answered only in the most general way. Varieties have not done equally well in the three orchards; none of the trees are yet near their maximum usefulness; the question of longevity must be taken into account; the use for which the apple is wanted, whether for home or market, is a factor. Without discussing these several factors or giving reasons, the writer, after the experience of several years, can express his judgment as to the varieties that are and are not suited for dwarfing stock.

All things considered, possibly McIntosh, Wealthy and the little Lady have been most satisfactory on dwarfs. Jonathan, Esopus, Grimes, Alexander, Wagener, Boiken and Bismarck have been very satisfactory. Twenty Ounce has been the most unsatisfactory; it failed to make a good union at the start and even the trees that made the best union have been unhappy on either of the dwarfing stocks. Baldwin, R. I. Greening, Rome, Ben Davis, Northern Spy, Sutton, the best known of the remaining 27 sorts, have not taken especially kindly to the dwarfing stocks.

CONCLUSIONS.

We may conclude from the work at this Station with dwarf apples:

First. In America it is difficult if not impossible to get varieties on the dwarfing stock one may choose because of confusion in stocks. Even could one be sure of the stock the cost of the orchard per tree, and more particularly per acre, since many trees are required, is high

Second. In the cold climate of New York there is much danger of winter-killing or winter-injury to the tenderer dwarf trees. The French Paradise stock is particularly tender to cold.

Third. The union between stock and cion when dwarfing stocks are used is not as good as in standard trees. A considerably greater loss must be expected from the breaking of trees because of poor unions. Trees on French Paradise make poorer unions than those on Doucin stocks.

Fourth. Many varieties throw out roots from the cion if the union is at or beneath the surface of the ground. This entails annually the task of removing roots springing from the cion, otherwise the dwarf trees quickly cease to be dwarfs. Many so-called dwarf orchards are not such, for upon examination it will be found that the root system comes chiefly from the cion.

Fifth. All dwarfing stocks have relatively shallow root systems which, under the conditions in which apples are generally grown in New York, are undesirable for several reasons; the trees, young or old, loaded or unloaded, blow over; the orchard cannot be properly cultivated; unquestionably, the shallow-rooted dwarfs suffer more from the annual American drouth than do the deep-rooted standards; lastly, root injuries from plow and cultivator are more frequent with shallow-rooted stocks, accounting in part for the suckering habit of dwarf apples. Because of such injuries it may be expected that the roots of dwarf trees will more often be diseased than those of standards.

Sixth. The suckering habit of the dwarf stocks is a vexatious trouble with which growers of dwarf trees must contend. Many suckers probably come, as we have said, from root injuries, but since dwarf stocks are usually propagated from cuttings or layers it is reasonable to suppose that they sucker more freely than the average standard tree.

Seventh. To secure true dwarfs undoubtedly there must be some summer pruning. In the exceedingly variable summer climate of New York it is very difficult to find a method and a time to prune satisfactorily in the summer. On the one hand, the results for which summer pruning is done do not always attend and on the other hand positive harm often follows because of the weak, sickly, second growth which so often is an after effect and which nearly always succumbs the succeeding winter.

Eighth. The data secured in this test show that the trees on dwarfing stocks come into commercial bearing somewhat earlier than do those on standard stocks. But, while the trees are not old enough to give reliable data on productiveness, there are no indications that the dwarfs come in bearing sufficiently early or bear enough fruit to make them profitable as compared with standards. This test, of course, offers no evidence, but no one expects from the behavior of dwarfs elsewhere, that the trees will live as long as do standards.

Ninth. It is a common claim that dwarf apple trees produce larger, handsomer and better-flavored fruits than standard trees. There is little in these three orchards to substantiate these claims. There are differences between trees on the three stocks but they are as often as not in favor of standards as of dwarfs.

Tenth. The chief advantages of the dwarf trees are such as appeal to the amateur rather than the professional apple grower. Thus, a dwarf tree takes less space and a greater variety can therefore be grown in a garden or orchard and the plants are handsomer ornamentals.

THE BLOOMING SEASON OF HARDY FRUITS.[1]*

U. P. HEDRICK.

In 1908 this Station published blooming data for 866 varieties of tree and vine fruits. Though a second edition has been published of Bulletin 299, which contained this information, it is now out of print and there is still a demand for it. Meanwhile, in the seven years that have elapsed, many new varieties of tree and vine fruits have been grown for which we now have data as we have also for bramble and bush fruits and strawberries. The present bulletin assigns a blooming season, from data taken at this Station, for all of the varieties of fruits commonly cultivated in New York. Of what value is this data?

The value of blooming data.—The blooming time of fruits governs the action of fruit-growers in several critical matters. Thus, the flowers of early-blooming sorts are often caught by spring frosts; knowing the blooming date, the grower can select late-blooming varieties for frosty sites or choose the most favorable part of his plantation for early bloomers. Again, it is certain that many fruits must be cross-pollinated to insure their setting a crop; only sorts that bloom at the same time should be inter-planted for cross-pollination. Lastly, some orchard operations are governed by blooming time; thus, several fruits are sprayed as blossoms are dropping and it is, therefore, wasteful of time to inter-set a plantation to varieties blooming widely apart since to do so makes it necessary to go over the orchard two or more times for this blooming-time spraying; on the other hand, it may be desirable to prolong the spraying season by planting two or more varieties in blocks blooming at different times.

At what stage of blooming should the date be taken?—There is a fine question as to whether the opening date of the flower, its full bloom or the dropping of its petals is most significant. For practical work in the orchard it makes little difference as to which of these events is indicated by the data provided that one of the three be adhered to for all data. In a careful study of blossom biology it is doubtful if any one of these stages of flower development is sufficiently refined; for the important event in the life of a flower is the breaking of the pollen sac or the time at which the stigma becomes receptive. This degree of refinement, however, is not necessary in practical work. The blooming seasons given for varieties in this bulletin are based upon the opening of flowers.

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[1] The blooming dates recorded in this Bulletin have been taken by various members of the Horticultural Department of this Station and the author has been assisted in assembling the data by all of the members of the Department.

* A reprint of Bulletin No. 407, May, 1915.

The effects of different temperatures on the essential organs of flowers.— There has long been a question in the mind of the writer as to whether the set of fruit might not be more or less influenced by a difference in the hastening or retarding effect of temperature on the two essential organs of flowers. The pistil, the female organ, and the stamen, the male organ, seem to be affected in different degree by cold and heat. Thus, all know that the pistil is often injured by a light frost which does no harm to the stamen. A considerable amount of work in cross-pollinating at this Station has led to the general observation that very warm weather leads to a more rapid development of the stamen than of the pistil. Not infrequently in exceptionally hot weather it will be found that the stamens have developed much more rapidly than the pistils — that the anthers have burst and lost their pollen before the stigmas are receptive. On the other hand the stamens develop least rapidily in cold weather. May not this unequal response of stamen and pistil to heat and cold be one of the causes of the uncertainty which attends the setting of fruit even when trees blossom well? Here is an important problem for some student of blossom biology.

The effects of moisture on the essential organs.—Rain during blossoming time, as we have shown in Bulletin 299 from this Station, is a frequent cause of a poor setting of fruit, doing damage oftener than frosts in New York. Usually the injurious action of rain on blossoms has been ascribed to the dilution of the stigmatic fluids or to its removal by washing out. During the current season Mr. W. F. Friedman, a student assistant at this Station, has found that pollen grains of practically all fruits burst and will not germinate in water. From his work, extending through the whole of the blooming season of 1915, there can be little doubt but that the action of rain on pollen is quite as potent in preventing a set of fruit as is its injurious effect on the stigmatic juices.

Variability in the blooming season.—Blooming time is a more or less shifting event. It is, of course, early or late as the season is early or late. It shifts also as regards other life events of plants. In some seasons a species or variety may bloom a little before leaves burst forth; in others, leaf and flower come out simultaneously and in still others leafing precedes blooming. In southern climates the tendency in several fruits is to bloom before they leaf, while in the north the same fruit will leaf and bloom together with the first wave of summer weather. More remarkable, and much more important, is the fact that varieties of most hardy fruits vary in their relative time of blooming; for example, one peach may bloom earlier this year than another and next year the time for the two may be reversed. These variations demand at least an attempt at an explanation.

There are several theories to account for variations in the time of occurence of life events in plants such as leafing, blooming and fruiting. Possibly the most generally accepted of these is that of Hoffman, briefly discussed in Bulletin 299 of this Station. The gist of Hoffman's hypothesis is that the beginning of any life-epoch in a plant marks a certain sum total of heat up to that event. Hoffman's zero point is arbitrarily fixed at the first of January, after which he takes the sum of the daily maximum positive temperatures of a thermometer exposed to the sun up to the beginning of the event. Hoffman holds that such a thermal constant coincides to a satisfactory degree from year to year.

If some such explanation be accepted one sees at once the cause of the variations in blooming time. Different species and different varieties, hypothetically, have different thermal constants and require a varying length of time in different climates and seasons to attain the thermal constant.

No doubt there are other causes of variations in time of blooming. The age and vigor of the plant may cause variation. As may, also, soil, moisture and all that go to make up the plant's environment. The stock may have a most decided influence. Rarely, it may be supposed, a plant normal in other respects may "sport" in the matter of time of blooming. It is probable that these conditions, affecting the vigor of the plant, account for the shifting in the relative time of blooming of varieties.

Influence of location on blooming time.—The time of blooming depends on temperature which, in its turn, is largely governed by latitude and altitude. In making use of the data to follow, then, it is somewhat important to know the latitude and altitude of this Station. The latitude is 42° 52′ 46.2″; the altitude is from 500 to 525 feet above sea level. On the several minor factors which affect temperature the only other one necessary to have in mind in regard to the Station orchard is that the land lies a mile west of Seneca Lake, a body of water 40 miles in length, 3½ miles wide and 600 feet deep — a lake, which because of its depth and size, exercises a powerful influence on the adjacent country, no doubt delaying the blooming time on the Station grounds several days each season.

The fruit-grower, in using such data, must usually make allowance for difference in latitude, altitude and distance from large bodies of water. But since the exact dates are not given and the procession of varieties will bloom approximately the same, subject to the variations discussed, the seasons may be generally accepted in New York as we give them in the lists that follow.

Comparative blooming dates.—A matter of much interest, and of no little importance in planning orchard work, is the dates at which the different fruits may be expected to bloom. We can best give this information by selecting an average year and giving dates of first bloom for the several fruits. The dates for other years will not be the same but the order of blooming will be. The year 1912, of the five seasons for which data are given, is most nearly an average one for blooming dates. In that year sweet cherries began blooming May 1; pears, May 2; European plums, Japanese plums, hybrid plums and currants, May 3; apples, sour cherries, hybrid cherries and gooseberries, May 4; peaches, May 5; crab apples, May 6; native plums, May 7; strawberries, May 16; blackberries, dewberries and black raspberries, May 31; red raspberries, June 1; hybrid raspberries, June 7; grapes, June 14.

APPLES.

The data presented cover the past five years. The blooming season of apples at this Station averages twelve days. The shortest season of bloom was seven days in 1913 and the longest season, eighteen days in 1910. The first date of bloom for apples in 1912, an average year, was May seventh.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Akin			*			Challenger			*		
Alexander			*			Charlock Reinette	*				
Alice			*			Chautauqua			*		
America				*		Chenango			*		
American Codling			*			Chester			*		
Anis Rose	*					Chicago			*		
Arabka			*			Clayton			*		
Arkansas			*			Clinton			*		
Arkansas Beauty			*			Coffelt			*		
Arkansas Black			*			Collamer			*		
Autumn Streaked		*				Collins		*			
Avery		*				Colton		*			
Axident				*		Constantine			*		
Babbitt			*			Cortland		*			
Bailey Sweet			*			Counseilor Niemetz			*		
Baker			*			Cox Orange			*		
Baldwin			*			Crimean		*			
Barnes Choice			*			Cross			*		
Barringer					*	Crow Egg				*	
Barton			*			De Chataigenier			*		
Baxter			*			Deacon Jones			*		
Bayard			*			Deaderick			*		
Beach			*			Delicious			*		
Belle Bonde					*	Dickey			*		
Ben Davis			*			Dickinson			*		
Ben Hur			*			Doctor			*		
Benninger			*			Donn Marie			*		
Birth			*			Draper		*			
Bismarck				*		Dumelow			*		
Black Ben Davis			*			Early Harvest		*			
Black Gilliflower				*		Early Joe			*		
Bloomfield			*			Eiser			*		
Blushed Calville	*					Ensee			*		
Blushing Bride		*				Eper			*		
Bogdanoff Glass			*			Esopus			*		
Boiken				*		Fall Pippin			*		
Bonum			*			Fameuse			*		
Boskoop		*				Fanny			*		
Bostick			*			Fishkill			*		
Boy's Delight			*			Flanders Pippin					*
Brackett			*			Florence			*		
Breskovka	*					Fraker			*		
Broome			*			French Pippin		*			
Brown			*			Gano			*		
Buda			*			Gem			*		
Cagle			*			Gideon		*			
Calville de Oullins			*			Golden Reinette			*		
Canada Baldwin			*			Golden Russet		*			
Canada Reinette			*			Golden Sweet		*			
Centennial			*			Good Peasant			*		
Century					*	Gracie			*		

	Very early.	Early.	Midseason.	Late.	Very late.
Graf Luxburg	...	...	...	*	...
Grand Duke Michel Pearmain	...	*	...	...	...
Grandmother	...	...	*	...	...
Gravenstein	...	*	...	...	...
Great Barbe	...	...	...	...	*
Green and Yellow Newtown	...	...	*	...	...
Grimes	...	...	*	...	...
Grosh	...	...	*	...	...
Hagloe	...	*	...	...	...
Halt	...	...	...	*	...
Hanlon	...	...	*	...	...
Haskell	...	...	*	...	...
Headlight	...	...	*	...	...
Hedrick	...	...	...	*	...
Henry Clay	...	*	...	...	...
Henry Clay Summer	...	...	...	*	...
Hilaire	...	...	*	...	...
Hoadley	...	...	*	...	...
Holland Pippin	...	...	*	...	...
Holland Winter	...	...	*	...	...
Houghton Sweet	...	...	*	...	...
Hubbardston	...	...	*	...	...
Hunterdon	...	...	*	...	...
Huntsman	...	...	*	...	...
Hurlbut	*	...	...	...	...
Hurne	...	...	*	...	...
Hyde King	...	...	*	...	...
Jack	...	...	*	...	...
Jackson	...	...	*	...	...
Jacobs Sweet	...	...	*	...	...
Jarvis	...	*	...	...	...
Jefferis	...	...	*	...	...
Jersey Black	...	...	*	...	...
Jersey Sweet	...	*	...	...	...
Johnson	...	...	*	...	...
Johnsonite	...	...	*	...	...
Jonathan	...	...	*	...	...
Jonathan Buler	...	...	*	...	...
Kalkidon	...	*	...	...	...
Kecskemet	...	...	*	...	...
King David	...	...	*	...	...
King of Pippins	...	...	*	...	...
Kinnaird	...	...	*	...	...
Kittageskee	*	...	...	...	...
Lady	...	...	*	...	...
Lady Sweet	...	...	*	...	...
Landon	...	...	*	...	...
Landsberg	...	...	*	...	...
Lawver	...	...	*	...	...
Lead	...	*	...	...	...
Legal Tender	...	...	*	...	...
Lehigh Greening	...	...	*	...	...
Lombard	...	...	*	...	...
Longevity	...	...	*	...	...
Longfield	*	...	...	...	...
Long Island Russet	...	...	*	...	...
Long Keeper	...	...	*	...	...
Lord Seedling	...	...	*	...	...
Lou	...	*	...	...	...
Louise	...	...	*	...	...
Loveland	...	...	...	*	...
Lowell	...	...	*	...	...
Luckey	...	...	*	...	...
Lubsk Queen	...	...	...	*	...
McCroskey	...	...	*	...	...
McIntosh	...	...	*	...	...
McLellan	...	...	*	...	...
Magnolia	...	...	...	*	...
Magog	...	...	*	...	...
Magyar	...	...	*	...	...
Maiden Blush	...	...	*	...	...
Mammoth	...	*	...	...	...
Mann	...	...	*	...	...
Marigold	...	...	*	...	...
Mihalyfi	...	...	*	...	...
Milden	...	...	*	...	...
Miller Seedless	...	...	*	...	...
Missouri Pippin	...	...	*	...	...
Mock	...	...	...	*	...
Mon Desire	...	...	*	...	...
Monmouth	...	...	*	...	...
Monroe Sweet	...	*	...	...	...
Montgomery	...	...	*	...	...
Moore Extra	...	...	*	...	...
Moore Sweet	...	...	...	*	...
Mother	...	...	...	*	...
Mountain Sweet	...	*	...	...	...
Moyer	...	...	...	...	*
Munroe Favorite	...	...	*	...	...
Munson	...	*	...	...	...
Nelson	...	*	...	...	...
New Water	...	*	...	...	...
Nitchner Strawberry	...	...	*	...	...
Northern Spy	...	...	...	*	...
Northwestern Greening	...	...	*	...	...
Norton Red	...	...	*	...	...
Nyari Piros	...	...	*	...	...
Oak	...	...	*	...	...
Oel Austin	...	...	...	*	...

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Old Garden			*			Red Seek-No-Further			*		
Oldenburg			*			Regmalard			*		
Olga	*					Rensselaer		*			
Oliver			*			Rhode Island Greening			*		
Olympia			*			Ribston			*		
Onondaga		*				Richard Early Winter			*		
Ontario			*			Richard Graft			*		
Opalescent			*			Rioter			*		
Oranie			*			Rittenhouse			*		
Orenco				*		Robert			*		
Ortley			*			Rockland			*		
Ostrakoff		*				Rome				*	
Oswego			*			Roxbury			*		
Oszi Vaj			*			Ruby Gem		*			
Otsego		*				Rudolph			*		
Overton			*			Rutherford			*		
Ozone			*			Salome			*		
Palouse			*			Sandy Glass			*		
Paragon			*			Saratoga			*		
Parker Seedless				*		Scarlet Pippin		*			
Parlin			*			Schenectady			*		
Parry White		*				Schoharie					*
Parson			*			Scott Winter		*			
Patten		*				Sekula			*		
Paul Long			*			Shackleford			*		
Payne				*		Shannon			*		
Peach Blow			*			Sheddan			*		
Pease			*			Shepherd Perfection			*		
Peck Pleasant			*			Shirley				*	
Perfect		*				Skank			*		
Perry			*			Skelton		*			
Peter			*			Smith Cider			*		
Pewaukee			*			Smokehouse		*			
Pickard			*			Snyder			*		
Pomme Grise		*				Spasovka			*		
Pomona				*		Spencer Seedless					*
Porter					*	Springdale		*			
Primate		*				Stark				*	
Prince Double		*				Starkey		*			
Princess Wilhelma			*			Stayman Winesap			*		
Prolific Sweeting			*			Stearns			*		
Pumpkin Sweet			*			Stewart Seedling			*		
Queen (West)			*			Streaked Pippin			*		
Ralls				*		Striped Fameuse		*			
Ramsdell Sweet			*			Stuart Golden			*		
Red and Green Sweet				*		Summer Wafer				*	
Red Astrachan		*				Sutton				*	
Red Canada			*			Swaar			*		
Red Carver			*			Sweet Jonathan			*		
Red June			*			Sweet Romanite				*	
Red Queen			*								

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Sweet Winesap			*			Wandering Spy		*			
Switzer	*					Washington Royal			*		
Terdika			*			Washington Strawberry		*			
Terry				*		Water			*		
Tioga			*			Wealthy		*			
Titovka			*			Wells			*		
Titus Pippin			*			Westchester			*		
Tolman Sweet			*			Whinery			*		
Tompkins King			*			Williams					*
Transparent de Cronals		*				Wilson Red June				*	
Tufts		*				Windsor		*			
Twenty Ounce			*			Wine Rubets	*				
Ulster			*			Winesap			*		
Ulysses			*			Winter Banana			*		
Vandevere			*			Wismer			*		
Vaughn Seedless				*		Wolf River			*		
Ver			*			Yellow Forest			*		
Victoria Sweet			*			Yellow Transparent			*		
Victuals and Drink			*			York Imperial				*	
Wabash Red			*			York Stripe			*		
Wagener			*			Zoar			*		
Walker Beauty			*			Zolotareff		*			
Wallace Howard			*			Zusoff			*		

CRABAPPLES.

The blooming season of Crabapples is a few days shorter than that of other apples and usually begins from two to four days later.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Algerienne				*		Montreal			*		
Cherry		*				Orange			*		
Currant		*				Paul Imperial		*			
Excelsior			*			Picta Striata			*		
Florence	*					Quaker			*		
Grant			*			Queen			*		
Hohenheimer		*				September			*		
Hyslop		*				Transcendant			*		
Large Red Siberian			*			Van Wyck				*	
Large Yellow Siberian			*			Whitney			*		
Martha			*			Young America			*		

PEARS.

During the past five years the blooming season of pears at this Station averaged ten days. The shortest season of bloom in this period was five days in 1911, and the longest season fifteen days in 1912. The first date of bloom for pears in 1912, an average year, was May second.

	Very early.	Early.	Midseason.	Late.	Very late.
Abraham	...	*	...	...	...
Alamo	...	...	*	...	...
Andre Desportes	...	...	*	...	...
Angouleme	...	...	*	...	...
Ansault	...	...	*	...	...
Appert	...	...	*	...	...
Bartlett	...	...	*	...	...
Bihorel	...	...	*	...	...
Blight Proof	...	...	*	...	...
Bordeaux	...	...	*	...	...
Bosc	...	*	...	...	...
Boussock	...	*	...	...	...
Canner	...	*	...	...	...
Chamogea	...	...	*	...	...
Cincincis	...	*	...	...	...
Clairgeau	...	...	*	...	...
Clapp Favorite	...	...	*	...	...
Cocklin	...	*	...	...	...
Col. Wilder	...	...	...	...	*
Craig	...	...	...	*	...
Dearborn	...	...	*	...	...
Desportes	...	...	...	*	...
Diamyo	...	*	...	...	...
Dorset	*	...	...	...	...
Douglas	...	...	*	...	...
Duhamel	...	...	...	*	...
Early Harvest	...	*	...	...	...
Early Wilder	...	...	*	...	...
Easter Beurre	...	...	*	...	...
Eastern Belle	...	...	*	...	...
Fitzwater	...	...	*	...	...
Flemish	...	...	*	...	...
Fox	...	*	...	...	...
Fred. Clapp	...	...	*	...	...
French	...	...	*	...	...
Gansel Seckel	...	*	...	...	...
Giffard	...	...	*	...	...
Golden Russet	...	...	...	*	...
Grand Isle	...	*	...	...	...
Hemminway	...	...	*	...	...
Heyst (Emile)	...	...	...	*	...
Howell	...	*	...	...	...
Japan	...	*	...	...	...
Jones	...	*	...	...	...
Kieffer	...	*	...	...	...
Koonce	...	...	*	...	...
Krull	...	...	*	...	...
Lady Clapp	...	*	...	...	...
Lamartine	...	*	...	...	...
Lawrence	...	*	...	...	...
Lawson	...	*	...	...	...
Le Conte	*	...	...	...	...
Lemon	...	*	...	...	...
Liegel	...	*	...	...	...
Lincoln	...	...	*	...	...
Lincoln Coreless	...	...	*	...	...
Longworth	...	*	...	...	...
Louise	...	...	*	...	...
Louvenjal	...	...	*	...	...
Lucrative	...	...	*	...	...
Lucy Duke	...	...	...	*	...
Madeleine	...	...	*	...	...
Magnate	...	...	*	...	...
Malines	...	*	...	...	...
Margaret	...	...	*	...	...
Mongolian	*	...	...	...	...
Mount Vernon	...	...	*	...	...
Nickerson	...	...	*	...	...
Ogereau	...	...	...	*	...
Olivier	...	...	*	...	...
Onondaga	...	...	*	...	...
Osband	...	*	...	...	...
P. Barry	...	...	...	*	...
Peffer	...	...	*	...	...
Pitmaston	...	...	*	...	...
Pound	...	*	...	...	...
President	...	...	*	...	...
President Mas	...	...	*	...	...
Raymond	...	...	*	...	...
Reeder	...	...	*	...	...
Ritson	...	...	*	...	...
Romain	...	*	...	...	...
Roosevelt	...	*	...	...	...
Rossney	...	...	*	...	...

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Russet Bartlett			*			Summer Beauty		*			
Seckel			*			Treyve	*				
Seneca			*			Triumph			*		
Sha Lea		*				Tyson			*		
Sheldon			*			Ulm			*		
Siebold			*			Vermont Beauty			*		
Souvenir			*			White Doyenne		*			
Souvenir (Esp.)				*		Winter Bartlett					*
Sudduth				*		Winter Nelis				*	

PEACHES.

During the four years which the data here presented cover, the blooming season of peaches at this Station has averaged ten days. The shortest season of blooming was six days in 1911; the longest, sixteen days in 1910. The first date of bloom for peaches in 1912, an average year, was May eighth.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Abundance		*				Beers			*		
A. C. Wooster		*				Bishop			*		
Ailsworth			*			Bilyeu		*			
Albright			*			Blood Cling			*		
Alexander		*				Blood Leaved			*		
Alton		*				Bokara			*		
Amelia			*			Bonanza			*		
Ameliaberta				*		Brandywine			*		
Anger			*			Bray Rareripe			*		
Argyle			*			Brigdon			*		
Arkansas			*			Briggs			*		
Arp			*			Bronson		*			
Athens			*			Burke			*		
Augbert			*			Buttram			*		
Bailey				*		Butler Late			*		
Banner				*		Capps			*		
Barber			*			Capt. Eads					*
Beach			*			Carman			*		
Beatrice			*			Champion			*		
Belle (of Georgia)		*				Chairs				*	
Ben Jean			*			Chase Early Free			*		
Bequett Free			*			Chilow			*		
Berenice			*			Chilow Cling				*	

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Chinese Cling			*			Gold Drop		*			
Chinese Free		*				Gold Dust			*		
Christiana			*			Gold Gate			*		
Clarissa			*			Gold Medal				*	
Clifton Park		*				Gold Mine			*		
Cobler			*			Gordon				*	
Concord			*			Gov. Garland			*		
Conkling				*		Gov. Hogg			*		
Connecticut			*			Graves			*		
Connet So. Early			*			Greensboro		*			
Cooledge			*			Guinn			*		
Crosby			*			Hale			*		
Crothers		*				Heath Cling			*		
Daniel Boone			*			Heath Free			*		
Davidson		*				Henrietta			*		
Delaware			*			Hiley			*		
Denton		*				Hill Home Chief			*		
Dewey			*			Hills Chili			*		
Double Crop				*		Holder			*		
Dr. Burton			*			Holland Cling			*		
Dulce				*		Honest John			*		
Dunn				*		Horton River		*			
Early Barnard				*		Hughes			*		
Early Beauty			*			Hynds Yellow			*		
Early Canada			*			Hynes Surprise			*		
Early Charlotte			*			Hyslop Cling			*		
Early Crawford			*			Illinois			*		
Early Elberta				*		Ingold				*	
Early Free			*			Iron Mountain				*	
Early Heath		*				Jackson				*	
Early Michigan		*				Jennie Worthen			*		
Early Rivers		*				Jennings			*		
Early York					*	Kalamasoo			*		
Easton Cling				*		Klondike			*		
Edgemont			*			Lafayette			*		
Elberta			*			Lambden				*	
Elberta Cling			*			Lamont			*		
Emma			*			Large Early York			*		
Engle			*			Late Crawford			*		
Eureka		*				Late Elberta			*		
Family Favorite		*				Late Rareripe			*		
Fitsgerald			*			Lee			*		
Ford Choice			*			Levy			*		
Ford Late		*				Lewis			*		
Foster			*			Lodge		*			
Fox				*		Lolo		*			
Frances				*		Lord Palmerston		*			
Frederica			*			Lorents			*		
G. A. Cling		*				McCollister			*		
Geary			*			McIntosh			*		
Geo. the 4th			*			McKay Late			*		

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Mamie Ross		*				Shipley Late			*		
Marcella				*		Simmons			*		*
Markham			*			Slappey					*
Martins Sept			*			Smock			*		
Massey Yellow			*			Sneed			*		
Matthew			*			Snow Ball Cling			*		
May Lee Cling			*			Steadly				*	
Maule Early			*			Stewart			*		
Mikado			*			Strout		*			
Miller				*		Stump			*		
Millhiser			*			Success			*		
Miner Wonder			*			Sunrise		*			
Moore Favorite				*		Surpasse			*		
Morris White			*			Surprise			*		
Mountain Rose			*			Susquehanna			*		
Munson Free			*			Switzerland			*		
Newcomber			*			Tennessee Everbearing			*		
Newington			*			Thurber			*		
New Prolific		*				Tiebout			*		
Niagara			*			Tillotson				*	
Northboro		*				Tornado			*		
Old Mixon Cling			*			Triumph		*			
Old Mixon Free			*			Troth			*		
Opulent			*			Uneeda Cling			*		
Oriole Cling			*			Van Meteors			*		
Orleans				*		Victor		*			
Ostrander Late			*			Waddell			*		
O. Z. Cling			*			Wager			*		
Parson Early			*			Walker			*		
Patterson			*			Ward Late			*		
Pearce Yellow			*			Washington			*		
Pearson	*					Waterloo			*		
Perfection			*			Weaver			*		
Philip Horton					*	Wellington				*	
Picquet			*			Wheatland				*	
Potter				*		Whitford Yellow				*	
Pratt				*		Wiard			*		
Prolific			*			Wilkins			*		
Ray			*			Willard			*		
Red Bird			*			Willett			*		
Red Bird Cling			*			Williams			*		
Red Cheek Melocoton			*			Wm. Lynn			*		
Reeves Favorite				*		Wonderful				*	
R. S. Stevens			*			Woolsey				*	
Rudings Late			*			Worlds Fair				*	
Russell		*				Worrell				*	
Salway			*			Wright				*	
Schumaker		*				Yellow Rareripe			*		
Scott Nonpariel			*			Yellow St. John			*		
Sea Eagle		*				Yellow Swan				*	

EUROPEAN PLUMS.

European plums are among the first to begin blossoming, yet they cover such a long season that some varieties are recorded as very late and are only slightly earlier than our latest natives. The blooming season may open from the middle of April up to the beginning of the second week in May and may be from one week to three weeks long. In 1912, an average year for plums, the first blossoms among Europeans were recorded May sixth and the last varieties to open were recorded on the sixteenth.

	Very early.	Early.	Midseason.	Late.	Very late.
Prunus domestica.					
Agen			*		
Althann			*		
Arch Duke			*		
Arctic			*		
Autumn Compote			*		
Bavay			*		
Belgian Purple			*		
Belle					*
Bradshaw			*		
Bryanston		*			
Chambourcy			*		
Champion			*		
Clingstem			*		
Clyman		*			
Copper		*			
Czar			*		
Diamond		*			
Duane	*				
Early Orleans			*		
Early Rivers			*		
Early Tours			*		
Empire			*		
Field		*			
Furst				*	
German Prune			*		
Golden Drop			*		
Goliath			*		
Grand Duke			*		
Gueii			*		
Guthrie Late		*			
Hand			*		
Hudson			*		
Hulings			*		
Hungarian			*		
Ickworth			*		
Prunus domestica (*continued*).					
Imperial Epineuse			*		
Imperial Gage			*		
Italian Prune				*	
Jefferson			*		
Kirke			*		
Lafayette			*		
Large English				*	
Late Muscatelle					*
Late Orleans			*		
Lucombe			*		
McLaughlin			*		
Middleburg			*		
Miller Superb			*		
Monarch			*		
Monroe			*		
Newark			*		
Orange			*		
Oullins			*		
Pacific				*	
Palatine			*		
Paul Early			*		
Pearl			*		
Peters			*		
Pond				*	
Purple Gage				*	
Quackenboss			*		
Red Date			*		
Red Magnum Bonum			*		
St. Catherine				*	
Saunders			*		
Sheldrake			*		
Shipper			*		
Smith Orleans			*		
Spaulding			*		

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Prunus domestica (*concluded*).						*Prunus insititia* (*concluded*).					
Tennant		*				Drap D'Or			*		
Tragedy		*				Freestone					*
Transparent			*			French			*		
Ungarish			*			Frogmore			*		
Victoria			*			Frost Damson			*		
Wales			*			King Damson			*		
Wangenheim				*		Late Mirabelle					*
Washington			*			Shropshire				*	
Yellow Egg			*			White Bullace				*	
Yellow Gage			*								
						Prunus cerasifera.					
Prunus insititia.						De Caradeuc		*			
Black Bullace			*			Golden Cherry	*				
Crittenden			*								

TRIFLORA PLUMS.

Although the Triflora plums begin to bloom at the same time as the European varieties, their season is much shorter — from four to eight days — so that late Triflora varieties fall in midseason for Domesticas.

	Early.	Midseason.	Late.		Early.	Midseason.	Late.
Abundance	*			Long Fruit			*
Burbank		*		Maru		*	
Chabot		*		Occident		*	
Earliest of All	*			October		*	
Engre		*		Ogon		*	
Georgeson		*		Red June		*	
Hale	*			Willard		*	

NATIVE PLUMS.

Varieties of five native species are growing at Geneva. These are much slower in starting into bloom than are the European varieties, the earliest usually blooming toward the latter part of the midseason for Domesticas, and they continue to open from a day to a week after the latter plums. The 1912 season opened on the eleventh of May and continued for six days. We have no other plums which bloom later than the Hortulanas.

	Early.	Midseason.	Late.		Early.	Midseason.	Late.
Prunus munsoniana.				*Prunus hortulana.*			
Newman		*		Golden Beauty			*
Poole Pride			*	Wayland			*
Pottawattamie		*		World Beater			*
Robinson		*					
Wild Goose		*		*Prunus hortulana mineri.*			
Prunus americana.				Forest Garden		*	
De Soto		*		Miner		*	
Oren		*		Surprise	*		
Rollingstone		*					
Stoddard		*		*Prunus americana mollis.*			
Weaver	*						
Wood	*			Wolf		*	

HYBRID PLUMS.

As would be expected, the blooming period of hybrid plums is considerably spread out—some coming in with the early Domesticas and Trifloras while others are nearly as late as the Hortulanas. In 1912 the season opened on the sixth of May and the last variety bloomed seven days later.

	Early.	Midseason.	Late.		Early.	Midseason.	Late.
America		*		Japex	*		
Ames			*	Juicy			*
Chalco		*		Marianna		*	
Climax		*		Maynard	*		
Golden		*		Miracle		*	
Gonzales		*		Shiro	*		
Hammer			*	Wickson		*	

SWEET CHERRIES.

The blooming season of sweet cherries at this Station averages six days. The data presented cover the past five years. The shortest season of bloom was four days in 1912, and the longest season eight days in 1911. The first date of bloom in 1912, an average season, was May first.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Allen			*			Kirtland				*	
Bing					*	Knight		*			
Black Tartarian		*				Lamaurie		*			
Burbank			*			Lambert			*		
California Advance	*					Lyons			*		
Centennial		*				Mercer			*		
Cleveland			*			Mezel			*		
Coe		*				Napoleon		*			
Dikeman		*				Republican		*			
Downer		*				Rockport			*		
Eagle			*			Schmidt			*		
Early Purple	*					Sparhawk		*			
Elkhorn			*			Stuart			*		
Elton		*				Summit				*	
Florence				*		Windsor		*			
Genesee			*			Wood			*		
Hoy				*		Yellow Spanish		*			
Ida		*									

SOUR CHERRIES.

The blooming season of sour cherries at this Station averaged eight days during the past five seasons. The shortest season of bloom was five days in 1911; the longest, eleven days in 1910. The first date of bloom in 1912, an average season, was May seventh.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Bourgueil			*			Double Natte		*			
Brusseler Braune			*			Dyehouse				*	
Carnation	*					Early Morello				*	
Cole					*	Early Richmond			*		

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
English Morello				*		Olivet	*				
George Glass				*		Ostheim		*			
Grosse Picarde				*		Riga				*	
Heart-Shaped Weichsel					*	Short-Stem Montmorency				*	
King Amarelle		*				Sklanka			*		
Large Montmorency			*			Spate Amarelle				*	
Louis Philippe		*				Suda				*	
Magnifique					*	Timme			*		
Montmorency			*			Tubbs				*	
Northwest				*		Vladimir				*	

HYBRID CHERRIES.

The blooming season of hybrid, or Duke cherries, is coincident with that of sour cherries.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Abbesse d'Oignies			*			New Century			*		
Bender (of New York)					*	Nouvelle Royale			*		
Empress Eugenie			*			Reine Hortense		*			
Late Duke					*	Royal Duke			*		
May Duke			*								

GRAPES.

From three years' records, the average length of blooming season for grapes has been twenty days, nineteen days in 1912 and 1914 and twenty-two days in 1913. The first date in the average year of 1912 was June fourteenth while for 1914 it was June seventh.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Adirondac			*			Alice			*		
Agawam			*			Amber Queen			*		
Alexander Winter		*				Ambrosia			*		

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
America				*		Delaware			*		
Amethyst				*		Diamond			*		
Aminia			*			Diana			*		
Antoinette			*			Downing			*		
Arkansas			*			Dracut Amber		*			
Aroma			*			Dry Hill Beauty			*		
August Giant			*			Dutchess				*	
Bacchus	*					Early Dawn			*		
Bailey					*	Early Golden				*	
Banner				*		Early Ohio		*			
Barry			*			Early Victor		*			
Beacon				*		Eaton			*		
Bell		*				Eclipse I			*		
Berckmans		*				Eclipse II				*	
Bertha			*			Eldorado			*		
Big Hope					*	Elsinburgh					*
Bishop			*			Elvibach		*			
Black Eagle			*			Elvira		*			
Brighton			*			Emerald			*		
Bridgewater			*			Empire State			*		
Brilliant			*			Essex			*		
Brown			*			Etta			*		
Campbell Early			*			Eumedel			*		
Canada		*				Eumelan				*	
Canandaigua			*			Extra					*
Captain				*		Faith		*			
Captivator			*			Fern Munson				*	
Carman					*	Gaertner			*		
Catawba			*			Garfield			*		
Cayuga			*			Geneva			*		
Champion		*				Glenfeld			*		
Champanel			*			Goethe			*		
Chambril			*			Goff			*		
Chandler			*			Gold Coin			*		
Chautauqua			*			Golden Drop			*		
Clevener	*					Gold Dust			*		
Clinton	*					Golden Grain			*		
Cloeta				*		Green Early			*		
Cochee			*			Grein Golden		*			
Colerain			*			Hartford			*		
Columbian Imperial			*			Headlight			*		
Collier				*		Helen Keller			*		
Concord			*			Herbert			*		
Corby			*			Hercules			*		
Cottage		*				Hernito			*		
Creveling			*			Hexamer				*	
Croton				*		Hicks			*		
Daisy			*			Hidalgo			*		
Delakins			*			Hopican			*		
Delago			*			Hopkins					*

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Hosford			*			Newburgh Muscat			*		
Hubbard Seedless			*			Niagara			*		
Hybrid Franc		*				Noah		*			
Illinois City				*		Nora					*
International		*				Norfolk			*		
Iona				*		Northern Muscadine		*			
Isabella		*				Norton					*
Janesville	*					Occidental			*		
Jefferson					*	Olita			*		
Jessica		*				Omega			*		
Jewel			*			Oneida			*		
Kensington		*				Oporto	*				
Kentucky			*			Osage			*		
King			*			Ozark				*	
Krause				*		Palermo			*		
Laconia			*			Paradox			*		
Lady Washington				*		Paragon			*		
L'Amoreaux			*			Peabody			*		
Leader			*			Pearl		*			
Lindley			*			Perfection			*		
Lindmar			*			Perkins			*		
Linn			*			Pierce			*		
Livingston			*			Pocklington			*		
Little Blue			*			Poughkeepsie				*	
Long John					*	Prentiss			*		
Lucile			*			President			*		
Lutie			*			Presley		*			
McPike			*			Pukwana			*		
McKinley			*			Pulaski			*		
Mabel			*			Pulliat					*
Magnate			*			Purity			*		
Mammoth			*			Rebecca			*		
Manito				*		Red Bird			*		
Mary Favorite		*				Red Eagle			*		
Marie Louise				*		Red Rover			*		
Marion	*					Red Riesling			*		
Martha			*			Regal			*		
Marsala			*			Requa			*		
Massasoit			*			Rochester			*		
Maxatawney			*			Rockwood			*		
Merrimac			*			Rommel			*		
Mills			*			Rupert			*		
Missouri Riesling		*				Rustler			*		
Montefiore			*			R. W. Munson				*	
Montclair			*			St. Hilaire	*				
Moore Early			*			St. Louis			*		
Moyer			*			Salem			*		
Munson			*			Sanbornton			*		
Nectar			*			Santa Clara				*	
Neosho					*	Secretary			*		

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Senasqua				*		Victoria			*		
Shelby			*			Waldo			*		
Standard			*			Wapanuka			*		
Stark-Star				*		Western Beauty				*	
Sterling			*			Wheaton			*		
Sunrise			*			White Imperial			*		
Superb			*			Wilder			*		
Telegraph			*			Willard			*		
Tonkawa			*			Winchell			*		
Triumph				*		Wine King				*	
Ulster		*				Worden			*		
Vergennes			*			Wyoming			*		

GOOSEBERRIES.

The average length of blooming season of gooseberries at this Station for the past three years is ten days. The shortest season was nine days in 1914 and the longest season twelve days in 1912. The first date of bloom for gooseberries in 1912, an average year, was May seventh.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Antagonist					*	**Gipsy Queen**				*	
Berkeley			*			**Golden Prolific**				*	
Blucher			*			**High Sheriff**		*			
Candidate				*		**Houghton**				*	
Careless			*			**Industry**			*		
Carrie			*			**Jolly Angler**					*
Carman				*		**Josselyn**		*			
Catherine				*		**Keepsake**				*	
Chautauqua			*			**King of Trumps**			*		
Dominion	*					**Lady Houghton**			*		
Downing		*				**Lady Popham**					*
Drill			*			**Lancashire Lad**					*
Duke of Sutherland			*			**Leigh**				*	
Duplication		*				**Leveller**				*	
Early Hedgehog			*			**Lord Beaconsfield**				*	
Freedom		*				**Matchless**			*		
Galopin			*			**May Duke**	*				
General		*				**Monument**				*	

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Oregon	...	...	*	...	...	Smiling Beauty	...	...	*	...	...
Oskender Bey	...	*	...	...	...	Stockwell	...	*	...	...	...
Overall	...	...	*	...	...	Succeed	...	...	*	...	...
Ozonne	...	...	*	...	...	Sulphur	...	...	...	*	...
Pearl	*	...	...	...	...	Sunset	...	...	...	...	*
Poorman	...	...	*	...	...	Tally Ho	...	...	*	...	...
Portage	...	*	...	...	...	Thumper	...	...	*	...	...
Queen of Whites	...	...	*	...	...	Victoria	*	...	...	...	...
Red Champagne	...	...	...	*	...	Wellington	*	...	...	...	...
Red Warrington	...	...	*	...	...	White Eagle	...	...	...	*	...
Rough Yellow Scotch	...	...	*	...	...	Whitesmith	...	*	...	...	...
Smith	...	*	...	...	...						

CURRANTS.

From three years' records, the average length of blooming season for currants has been eight days; seven days in 1913, eight in 1914 and nine in 1912. The first date in 1912, the season which is being used to show relative dates for the different fruits, was May sixth.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Black Victoria	...	...	...	*	...	Naples	...	...	...	...	*
Boskoop Giant	...	...	...	*	...	North Star	...	*	...	...	...
Champion	...	...	...	*	...	Perfection	...	*	...	...	...
Chautauqua	...	*	...	...	...	Pomona	...	...	*	...	...
Cherry	...	*	...	...	...	Prince Albert	...	...	*	...	...
Comet	...	*	...	...	...	Red Cross	...	...	*	...	...
Crandall	...	...	*	...	...	Red Dutch	...	*	...	...	...
Diploma	...	...	*	...	...	Ruby	...	*	...	...	...
Fay	...	*	...	...	...	Versailles	...	...	*	...	...
Filler	...	...	*	...	...	Victoria	...	...	*	...	...
Franco German	...	...	*	...	...	White Dutch	...	...	*	...	...
Holland	...	...	*	...	...	White Grape	...	...	*	...	...
Lee	...	...	...	*	...	White Imperial	...	...	*	...	...
London Market	...	...	*	...	...	White Transparent	...	*	...	...	...
Magnum Bonum	...	*	...	...	...	Wilder	...	*	...	...	...

BLACKBERRIES AND DEWBERRIES.

The average length of blooming season of blackberries and dewberries at this Station for three years is twenty-four days. The shortest season was twenty days in 1914 and the longest season twenty-seven days in 1913. The first date of bloom for blackberries in 1912, an average year, was May thirty-first, and for dewberries June first.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late	Very late.
Agawam	*					Minnewaska			*		
Blowers				*		McDonald (Dewberry)		*			
Briton			*			Ohmer			*		
Early Harvest			*			Premo (Dewberry)		*			
Eldorado			*			Rathbun			*		
Erie		*				Snyder		*			
Giant Himalaya					*	Sorsby May				*	
Joy			*			Taylor			*		
Kenoyer					*	Ward			*		
Kittatinny			*			Wilson				*	
Lucretia (Dewberry)		*				Watt			*		
Mersereau			*								

RED, YELLOW AND HYBRID RASPBERRIES.

The average length of blooming season of red, hybrid and yellow raspberries at this Station for three years is fourteen days. The shortest season was fourteen days, 1913 and 1914, and the longest season fifteen days in 1912. The first date of bloom for red raspberries in 1912, an average year, was June first; for hybrid raspberries, June seventh; and for yellow raspberries, June eleventh.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Brilliant			*			Eaton			*		
Buckeye		*				Golden Queen (Yellow)			*		
Columbian (Purple)			*			Haymaker (Purple)					*
Cuthbert			*			Herbert				*	
Donboro			*			Idaho			*		

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
June	*					Ruby		*			
Marlboro		*				Ranere (St. Regis)			*		
Marldon			*			Segrist				*	
Miller			*			Shaffer (Purple)				*	
Minnetonka			*			Surprise	*				
Olita		*				Syracuse			*		
Perfection		*				Turner			*		
Red Antwerp			*			Twentieth Century					*
Royal Purple (Purple)				*		Watson			*		

BLACK RASPBERRIES.

The average length of blooming season of black raspberries at this Station for three years is seven days. The shortest season was six days in 1912 and the longest season nine days in 1914. The first date of bloom for black raspberries in 1912, an average year, was May thirty-first.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Black Pearl			*			Mammoth Cluster	*				
Cumberland				*		Midwest					*
Diamond		*				Ohio		*			
Eureka			*			Palmer	*				
Gault				*		Plum Farmer			*		
Gregg				*		Rachel					*
Hilborn			*			Souhegan			*		
Hoosier			*			Stone Fort			*		
Johnson Sweet			*			Winfield			*		
Kansas			*								

STRAWBERRIES.

The average length of blooming season of strawberries at this Station for five years is seventeen days. The shortest season was eleven days in 1912 and the longest season twenty-six days in 1910.

The first date of bloom for strawberries in 1912, an average year, was May sixteenth.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Abington			*			Good Luck				*	
Amanda			*			Goodwin				*	
Americus		*				Goree				*	
Atkins Continuity			*			Gov. Fort				*	
Autumn				*		Gov. Rollins		*			
Baltimore		*				Granger			*		
Barkley			*			Grand Marie			*		
Barrymore				*		Gray Dollar			*		
Battenburg			*			Greenwood			*		
Bederwood	*					Helen Davis				*	
Bethel				*		Highland			*		
Berlin			*			Hub				*	
Big Rock				*		Hughson				*	
Black Beauty		*				Indiana					*
Bradley			*			Ionia Market			*		
Brandywine			*			Iowa		*			
Bull Moose				*		Irena		*			
Buster				*		James Todd				*	
Carrie Silvers		*				Joe				*	
Chesapeake					*	July					*
Clara			*			Kevitt Wonder			*		
Climax			*			Killarney			*		
Columbia					*	Kittie Rice			*		
Consort		*				Klondike					*
Corinne			*			Labell				*	
Danby			*			Latest of All					*
Darlington						Late Jersey Giant				*	
Dawley			*			Laxton Latest			*		
Deacon			*			Lea		*			
Dewdrop				*		Magnus				*	
Dicky			*			Manhattan			*		
Dighton		*				Marshal			*		
Dixon					*	Maryland Prize		*			
Dunmore		*				Mascot					*
Dunlap			*			Matthew Crawford					*
Early Jersey Giant			*			Maud Muller		*			
Early Ozark		*				Meteor				*	
Early Queen		*				Missionary		*			
Ekey		*				Model				*	
Ernest			*			Monroe		*			
Fillbasket					*	Myer		*			
First Prize		*				Nanticoke		*			
First Quality				*		Nettie				*	
Four Seasons		*				New Discovery			*		
Glastonbury			*			Norwood			*		
Golden Gate			*			Ohio Boy					*
Goodell			*			Omega					*

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Orem				*		Saint Joseph	*				
Orphan					*	Sample			*		
Outlander					*	Saratoga		*			
Pan American			*			Sherman			*		
Parcell Early	*					Silver Coin			*		
Patagonia			*			Sons Prolific		*			
Paul Jones		*				Stevens Great American			*		
Peach				*							
Peckham Wonder			*			Stevens					*
Phoenix				*		Superb					
Posey				*		Superior	*				
Productive			*			Swedenberg		*			
Prof. Fisher					*	Sweetheart			*		
Progressive	*					Townsend Late Champion				*	
Prolific				*							
Quality					*	Twilley			*		
Red Bird		*				Uncle Sam		*			
Red Prolific		*				Walnut Stump				*	
Repeater				*		W. H. Taft					
Rose Ettersburg				*		Winner		*			
Rough Rider			*			Wooster			*		
Saint Fiacre		*									

RIPENING DATES AND LENGTH OF SEASON FOR HARDY FRUITS.[1]*

U. P. HEDRICK.

Accurate knowledge of time of ripening and length of season of varieties is information that the commercial fruit grower must have. It is not sufficient that he know roughly what the season of his fruits is. To take the turn of the markets he should know exactly when a variety will ripen and how long it will keep. Yet current data on fruit maturity are notoriously unreliable. One can readily account for the untrustworthiness of maturity data. In the first place there is no general agreement as to when fruit is ripe nor how long it is fit to eat.

When is fruit ripe?— There is no way of demarcating greenness, maturity and decay; these stages in the development of a fruit grade insensibly into each other. Shakespeare might well have had the ripening of fruit in mind when he wrote—

> " And so from hour to hour we ripe and ripe,
> And then from hour to hour we rot and rot;
> And thereby hangs a tale."

But we cannot tell exactly when any fruit ceases to " ripe and ripe " and begins to " rot and rot." It is a commercial necessity to pick many fruits more or less green in order to have them reach market in suitable condition. Disagreements as to time of maturity arise, then, because we cannot recognize the stage of development known as " ripeness " and because fruits are usually picked in a more or less unripe state for the markets. So, too, depending upon tastes and the purposes to which fruit is to be put, whether to be eaten out of hand or used for culinary purposes, there is much variation in the length of time fruit is kept.

Variability in ripening dates and keeping quality — Confusion arises, too, of course, from the fact that varieties ripen at different times in different places. It is difficult for a New Yorker, for example, to make allowances in season for a variety the time of ripening of which he has, say, for Missouri. Besides, there are always those to whom " it is printed in a book " is sufficient and a ripening date printed for Missouri is taken as the date for New York. Pomologists are not a little to blame for the confusion that exists as to the season for varieties of the several fruits for they many times fail to state where a fruit, of which they give the season, was grown.

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[1] Ripening data have been taken by all of the members of the Horticultural Department and all have had a hand in preparing them for publication.

* A reprint of Bulletin No. 408, June, 1915.

There are other causes than seasonal differences for the variability in ripening time. Some soils are warmer and quicker than others and on these fruits ripen relatively early. In the several tillage and sod-mulch experiments at this Station, apples under tillage have been later in ripening and have kept longer than those grown in sod. Heavy applications of nitrogenous fertilizers and plowing under leguminous cover-crops delay the period of ripening somewhat. Fruit crops ripen a little earlier on old plants than on young ones; this is particularly true of strawberries: Then there are the local conditions on every farm, as lay of land, nearness to water, air currents and the like, that cause small variations. The shifting of the relative time of ripening of varieties of any fruit is probably due to these variations in environment and treatment.

As with blooming time, leafing time and other life events of plants there is probably a thermal constant for the ripening time of varieties of fruits. That is, it probably requires a certain sum total of degrees of heat, the zero point being some time before vegetation starts, to bring a variety of fruit to maturity.

Is there a correlation between blooming time and ripening time?—In the study of plants the correlation of organs or of functions is of fascinating scientific interest. Sometimes correlations are of practical import, with value to the grower as well as to the student. If time of blooming is correlated with the time of fruiting, one sees at once that the relation is of more than ordinary importance from several standpoints Do early varieties bloom earlier than late ones? If so, in frosty sites late varieties have an important advantage. In Bulletin 407 from this Station we gave the blooming time of the same list of fruits for which we here give the ripening time The data for these two bulletins were taken in the same years and are arranged about in the same way, giving a splendid opportunity to study correlations in these two events. It requires only a cursory comparison of the data in the two bulletins to show that there are no correlations between blooming time and ripening time of fruits.

Conditions affecting ripening time in the Station orchards.— While the data are so arranged that but few allowances need be made in New York for differences in environment, yet it is well for the fruit grower to know the conditions under which the fruits listed have been growing. The latitude is 42° 52′ 46.2″; the altitude is from 500 to 525 feet above sea level. The orchard lies a mile or thereabouts west of Seneca Lake, a body of water 40 miles long, 3½ miles wide and 600 feet deep, sufficiently large to delay the ripening time of most fruits a few days at least. The soil is a cold, heavy clay which must delay ripening time somewhat. The land is nearly level — without influence in time of maturity.

The first of the fruits to be discussed is the apple.

APPLES.

The dates given are those of maturity — the time when the fruit is first ready to eat out of hand — not picking dates, which for fall and winter fruits would be much earlier. Maturity is marked, in the table that follows, by the first ripe fruit and it is well to remember that some summer and fall varieties ripen over a period of several weeks. The criteria of maturity were color, taste, aroma and mellowness of flesh.

VARIETY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
Akin						10–20			15
Alexander			5–15						5
Alice		20–30							1
America					15–25				6
American Codling			5–15						2
Anis Rose		5–15							2
Arabka					5–15				8
Arkansas						15–30			13
Arkansas Beauty						1–15			14
Arkansas Black						15–20			14
Autumn Streaked			10–20						3
Avery			20–30						6
Axident						20–30			12
Babbitt						1–10			14

VARIETY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
Bailey Sweet				5-15					4
Baker				15-25					5
Baldwin						1-15			14
Barnes Choice			1-10						2
Barringer					5-15				7
Barton			15-25						7
Baxter					1-10				5
Bayard					15-20				8
Beach							15-20		11
Belle Bonde					1-10				6
Ben Davis						1-10			15
Ben Hur					20-30				8
Benninger		20-30							5
Birth			1-10						4
Bismarck				20-30					9
Black Ben Davis						1-10			12
Black Gilliflower					5-15				8
Bloomfield				5-15					5
Blushed Calville		15-25							2
Blushing Bride				20-30					6
Bogdanoff Glass					10-20				7
Boiken					20-30				9
Bonum					5-15				8
Boskoop					15-30				7
Bostick				20-30					7
Boy's Delight				20-30					7
Brackett						20-30			10
Breskovka		10-15							3
Broome					15-25				7
Brown			5-15						4
Buda			10-20						4
Cagle							5-15		11
Calville de Oullins							1-10		8
Canada Baldwin					1-10				10
Canada Reinette					5-15				7
Centennial				5-15					5
Century					10-20				9
Challenger					20-30				9
Charlock Reinette		15-25							6
Chautauqua						1-15			13
Chenango			1-10						3
Chester			1-10						3
Chicago					15-25				9
Clayton							15-25		11
Clinton						5-15			9
Coffelt							20-30		10
Collamer				20-30					4
Collins							5-15		8
Colton		5-15							2
Constantine			20-30						5
Cortland					5-15				9

VARIETY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
Counsellor Niemetz					5–15				6
Cox Orange					1–10				8
Crimean			1–10						3
Cross			1–10						4
Crow Egg				5–15					10
De Chataigenier						15–25			9
Deacon Jones						1–10			12
Deaderick					5–15				7
Delicious					15–25				10
Dickey						1–10			15
Dickinson					15–25				9
Doctor					20–30				8
Donn Marie					20–30				9
Draper					20–30				5
Dumelow						10–25			8
Early Harvest		1–10							1
Early Joe		20–30							3
Eiser					20–30				7
Ensee					10–20				8
Eper						15–30			12
Esopus					15–25				13
Fall Pippin				5–15					7
Fameuse				5–15					8
Fanny		15–25							4
Fishkill					1–10				5
Flanders Pippin					10–20				8
Florence					10–20				11
Fraker						20–30			5
French Pippin				15–25					8
Gano						1–10			12
Gem		15–25							3
Gideon				1–10					6
Golden Reinette		15–25							2
Golden Russet							1–10		15
Golden Sweet		10–20							2
Good Peasant			25–30						2
Gracie		25–30							2
Graf Luxburg			15–25						1
Grand Duke Michel Pearmain					1–10				5
Grandmother					10–20				7
Gravenstein		20–30							6
Great Barbe						1–10			8
Green and Yellow Newtown							20–30		16
Grimes					1–10				12
Grosh				1–10					4
Hagloe		20–30							4
Halt					1–10				8
Hanlon				5–15					6
Haskell				5–15					4

VARIETY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
Headlight					15–25				5
Hedrick					15–25				8
Henry Clay Summer				10–20					4
Hilaire					5–15				5
Hoadley				10–20					4
Holland Pippin				1–10					8
Holland Winter					1–10				9
Houghton Sweet			15–25						4
Hubbardston					1–10				11
Hunterdon						1–10			9
Huntsman						1–10			9
Hurlbut					5–15				8
Hurne						20–30			12
Hyde King						15–25			9
Jack					1–10				6
Jackson							1–10		12
Jacobs Sweet					15–25				5
Jarvis		20–30							3
Jefferis		20–30							4
Jersey Black					20–30				6
Jersey Sweet			10–20						3
Johnson							1–15		9
Johnsonite								1–10	8
Jonathan					15–25				14
Jonathan Buler						20–30			8
Kalkidon					15–25				5
Kecskemet					1–10				8
King David					5–15				12
King of Pippins				20–30					5
Kinnaird					15–25				8
Kittageskee					20–30				9
Lady						5–15			13
Lady Sweet					15–25				7
Landon							5–15		10
Landsberg				15–25					5
Lawver							10–20		12
Lead		20–30							4
Legal Tender								15–25	5
Lehigh Greening						20–30			11
Lombard					1–10				8
Longevity							10–15		10
Longfield			15–25						4
Long Island Russet							15–25		11
Long Keeper							10–20		14
Lord Seedling			20–30						5
Lou		5–15							2
Louise					1–10				7
Loveland					1–10				5
Lowell			10–20						3
Luckey					15–20				11
McCroskey						5–15			9

VARIETY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
McIntosh				15–25					9
McLellan				15–25					8
Magnolia					15–25				6
Magog					10–20				6
Magyar						20–30			9
Maiden Blush			15–25						7
Mammoth					20–30				9
Mann							5–15		11
Marigold						5–15			9
Mihalyfi					20–30				7
Milden					20–30				7
Miller Seedless			15–25						4
Missouri Pippin					20–30				8
Mock							15–25		7
Mon Desire				15–25					4
Monmouth							10–20		11
Monroe Sweet			1–10						3
Montgomery			1–10						2
Moore Extra					5–15				7
Moore Sweet					15–25				8
Mother					15–25				8
Mountain Sweet			10–20						5
Moyer					20–30				8
Munroe Favorite								10–20	6
Munson					1–10				5
Nelson							5–15		11
Nitchner Strawberry		10–20							3
Northern Spy						5–15			14
Northwestern Greening							1–10		11
Norton Red					15–25				9
Nyari Piros			1–10						4
Oak				5–15					4
Oel Austin				5–15					6
Old Garden			1–10						2
Oldenburg		1–10							2
Olga		10–20							2
Oliver						20–30			15
Olympia					20–30				10
Onondaga					1–10				5
Ontario					15–25				7
Opalescent				15–25					9
Oranie		20–30							2
Orenco			15–25						3
Ortley						1–10			10
Ostrakoff			10–20						2
Oswego					20–30				11
Oszi Vaj	20–30								1
Otsego					5–15				8
Overton					15–25				12
Ozone						10–15			6
Palouse			1–10						5

VARIETY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
Paragon							1–10		13
Parlin					15–25				7
Parry White		20–30							3
Parson			20–30						5
Patten				5–15					4
Paul Long					1–10				5
Payne							1–10		10
Peach Blow			10–20						2
Pease					1–10				5
Peck Pleasant							5–15		13
Perfect							20–30		13
Perry							1–10		8
Peter				1–10					4
Pewaukee						5–15			10
Pickard						15–25			9
Pomme Grise						10–20			11
Pomona		20–30							3
Porter			20–30						6
Primate		5–15							3
Prince Double			1–10						5
Princess Wilhelma					1–10				6
Prolific Sweeting		15–25							2
Pumpkin Sweet					5–15				5
Queen (West)							1–10		11
Ralls							1–10		15
Ramsdell Sweet			20–30						7
Red and Green Sweet			1–10						4
Red Astrachan	20–30								3
Red Canada						1–10			9
Red Carver					1–10				9
Red June		1–10							3
Red Queen					15–25				7
Red Seek-No-Further					1–10				7
Regmalard					5–15				6
Rensselaer					15–25				7
Rhode Island Greening					20–30				12
Ribston				15–25					7
Richard Early Winter				1–10					5
Richard Graft			10–20						2
Rioter			1–10						3
Rittenhouse				20–30					4
Robert			1–10						3
Rockland					1–10				7
Rome						1–10			12
Roxbury							1–10		15
Ruby Gem		10–20							2
Rudolph						1–10			6
Rutherford							15–25		10
Salome					20–30				9
Sandy Glass			10–20						6
Saratoga						20–30			12

VARIETY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
Scarlet Pippin					1-10				8
Schenectady				20-30					8
Schoharie					5-15				11
Scott Winter					5-15				9
Sekula							1-10		9
Shackleford					5-15				6
Shannon						5-15			8
Sheddan							1-10		7
Shepherd Perfection					5-15				8
Shirley			20-30						3
Skank				15-25					4
Skelton			20-30						3
Smith Cider					15-25				8
Smokehouse					20-30				9
Snyder							15-20		9
Spasovka		10-20							2
Springdale							1-10		8
Stark						20-30			11
Starkey					10-20				4
Stayman Winesap						15-25			13
Stearns				20-30					4
Stewart Seedling							15-25		9
Streaked Pippin					10-20				7
Striped Fameuse				15-25					8
Stuart Golden						1-10			8
Summer Wafer			20-30						5
Sutton					5-15				7
Swaar						1-10			12
Sweet Jonathan				20-30					6
Sweet Romanite					15-25				7
Sweet Winesap					5-15				6
Switzer		1-10							2
Terdika							15-25		10
Terry							15-25		8
Tioga						5-15			9
Titovka		5-15							2
Titus Pippin					20-30				8
Tolman Sweet					5-15				11
Tompkins King					15-25				9
Transparent de Cronals			1-10						2
Tufts				15-25					7
Twenty Ounce			20-30						6
Ulster						20-30			14
Ulysses					15-25				5
Vandevere						5-15			15
Vaughn Seedless							10-20		6
Ver				20-30					4
Victoria Sweet				15-25					4
Victuals and Drink				1-10					5
Wabash Red						20-30			9
Wagener					15-25				8

VARIETY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
Walker Beauty					15–25				7
Wallace Howard						15–25			6
Wandering Spy						15–25			7
Washington Royal						1–10			7
Washington Strawberry				10–20					6
Water					10–20				7
Wealthy			10–20						5
Wells					10–20				6
Westchester					15–25				9
Whinery							10–20		10
Williams		15–25							4
Wilson Red June			1–10						3
Windsor							5–15		8
Wine Rubets		10–20							1
Winesap						15–25			11
Winter Banana					15–25				9
Wismer				10–20					5
Wolf River			5–15						5
Yellow Forest						15–25			10
Yellow Transparent	10–30								2
York Imperial							1–10		12
York Stripe			10–20						2
Zoar				15–25					5
Zolotareff		20–30							4
Zusoff			5–15						5

CRABAPPLES

VARIETY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
Algerienne			20–30						3
Cherry		15–25							2
Currant				15–25					5
Excelsior			1–10						2
Florence		5–15							2
Grant			10–20						2
Hohenheimer			15–25						3
Hyslop			10–20						6
Large Red Siberian		15–25							3
Large Yellow Siberian			10–20						4
Martha		20–30							3
Montreal			10–20						4
Orange			1–10						6

VARIETY	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
Paul Imperial		5-15							2
Picta Striata				10-20					3
Quaker				15-25					2
Queen			10-20						2
September		20-30							3
Transcendent		20-30							3
Van Wyck			1-10						2
Whitney		15-25							3
Young America		20-30							2

PEARS

As with apples, the dates are those of maturity — very important to remember, for most pears are picked green and ripen in storage. Maturity was marked by color, taste, aroma and mellowness.

VARIETY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
Alamo		20-30							1
Angouleme				15-25					3
Ansault			15-25						4
Appert			20-30						2
Bartlett			5-15						1
Bihorel		5-15							1
Bordeaux						1-10			5
Bosc				20-30					2
Boussock			1-10						2
Canner			20-30						3
Cincinsis								15-25	4
Clairgeau				20-30					2
Clapp Favorite		20-30							1
Cocklin				15-25					5
Craig				1-10					2
Dearborn		20-30							1
Desportes			20-30						2
Diamyo						15-25			4
Dorset					10-20				3
Duhamel				1-10					2
Early Harvest		1-10							1
Easter Beurre						15-25			5
Eastern Belle			10-20						2
Fitzwater			20-30						2

VARIETY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
Fox				1–10					3
Fred. Clapp				5–15					3
French			1–10						1
Gansel Seckel				20–30					3
Golden Russet							1–10		8
Grand Isle			20–30						1
Hemminway			20–30						2
Heyst (Emile)				20–30					3
Howell				20–30					2
Japan								1–10	6
Jones					1–10				3
Kieffer				20–30					3
Koonce		1–10							1
Krull							15–25		10
Lady Clapp			15–25						1
Lamartine				20–30					4
Lawrence					1–10				4
Lawson		1–10							1
Le Conte				10–20					2
Lemon		15–25							1
Liegel				20–30					3
Lincoln		15–25							2
Lincoln Coreless								15–25	8
Longworth				1–10					3
Louise				1–10					2
Louvenjal				5–15					2
Lucrative			20–30						1
Lucy Duke				20–30					3
Magnate				10–20					2
Malines					1–10				4
Mongolian					1–10				4
Mount Vernon				15–25					6
Nickerson				10–20					4
Olivier						1–10			6
Onondaga				1–10					2
P. Barry						1–10			8
Peffer				10–20					2
Pitmaston				15–25					2
Pound								15–25	9
Raymond			20–30						3
Reeder				1–10					2
Ritson				1–10					2
Romain		15–25							1
Roosevelt			20–30						4
Russet Bartlett			20–30						2
Seckel				1–10					3
Seneca			20–30						1
Sha Lea							10–20		10
Sheldon				1–10					4
Siebold				10–20					4
Souvenir			5–15						2

VARIETY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Number of weeks in common storage.
Sudduth			20-30						3
Treyve			15-25						2
Triumph						1-10			3
Tyson		20-30							1
Ulm			20-30						2
Vermont Beauty				5-15					3
White Doyenne				5-15					2
Winter Bartlett				15-25					2
Winter Nelis					1-10				7

PEACHES.

Peaches usually begin to ripen at this Station the last week in July. For the four past years, which the data given cover, the average length of the peach season was 94 days, the shortest season being 90 days in 1912 and the longest 105 days in 1913.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Abundance			*			Bequett Free			*		
A. C. Wooster				*		Berenice			*		
Ailsworth				*		Beers					*
Albright			*			Bishop			*		
Alexander	*					Bilyeu					*
Alton			*			Blood Cling					*
Amelia			*			Blood Leaved					*
Ameliaberta				*		Bokara			*		
Anger				*		Bonanza					*
Argyle				*		Brandywine				*	
Arkansas		*				Bray Rareripe					*
Arp		*				Brigdon			*		
Athens				*		Briggs		*			
Augbert				*		Bronson				*	
Bailey				*		Burke			*		
Banner				*		Buttram				*	
Barber			*			Butler Late				*	
Beach			*			Capps			*		
Beatrice		*				Capt. Eads			*		
Belle (of Georgia)			*			Carman		*			
Ben Jean					*	Champion			*		

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Chairs			*			Frederica				*	
Chase Early Free						G. A. Cling				*	
Chilow				*		Geary					*
Chilow Cling				*		Geo. the 4th			*		
Chinese Cling				*		Gold Drop				*	
Chinese Free			*			Gold Dust				*	
Christiana				*		Gold Medal				*	
Clarissa				*		Gold Mine				*	
Clifton Park		*				Gordon					*
Cobler			*			Gov. Garland			*		
Concord				*		Gov. Hogg		*			
Conkling			*			Graves			*		
Connecticut			*			Greensboro		*			
Connet So. Early		*				Guinn			*		
Cooledge			*			Hale			*		
Crosby				*		Heath Free				*	
Crothers				*		Heath Cling					*
Daniel Boone			*			Henrietta					*
Davidson		*				Hiley			*		
Delaware			*			Hill Home Chief				*	
Denton			*			Hills Chili				*	
Dewey		*				Holder			*		
Double Crop						Holland Cling				*	
Dr. Burton			*			Honest John			*		
Dulce					*	Horton River			*		
Dunn			*			Hynds Yellow			*		
Early Beauty				*		Hynes Surprise		*			
Early Canada	*					Hyslop Cling				*	
Early Charlotte			*			Illinois				*	
Early Crawford			*			Ingold			*		
Early Elberta				*		Iron Mountain					*
Early Free						Jackson			*		
Early Heath			*			Jennie Worthen			*		
Early Michigan			*			Jennings			*		
Early Rivers		*				Kalamazoo				*	
Early York			*			Klondike				*	
Easton Cling			*			Lambden				*	
Edgemont			*			Lamont				*	
Elberta			*			Large Early York			*		
Elberta Cling			*			Late Crawford				*	
Emma			*			Late Elberta			*		
Engle			*			Late Rareripe				*	
Eureka			*			Lee			*		
Family Favorite			*			Levy					*
Fitzgerald			*			Lodge			*		
Ford Choice			*			Lola			*		
Ford Late				*		Lord Palmerston				*	
Foster			*			Lorents					*
Fox				*		McCollister			*		
Frances				*		McIntosh			*		

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
McKay Late					*	Shipley Late				*	
Mamie Ross			*			Simmons					*
Marcella					*	Slappey				*	
Markham			*			Smock					*
Martins Sept					*	Sneed	*				
Massey Yellow				*		Snow Ball Cling				*	
Mathew				*		Steadly					*
May Lee Cling		*				Stewart				*	
Maule Early		*				Strout	*				
Millhiser					*	Stump				*	
Miner Wonder				*		Success					*
Moore Favorite				*		Sunrise					*
Morris White				*		Surpasse			*		
Mountain Rose			*			Surprise			*		
Munson Free				*		Susquehanna			*		
Newcomber			*			Switzerland				*	
Newington					*	Tennessee Everbearing				*	
New Prolific			*			Thurber			*		
Niagara			*			Tiebout				*	
Northboro			*			Tillotson			*		
Old Mixon Cling				*		Tornado				*	
Old Mixon Free				*		Triumph		*			
Opulent			*			Troth			*		
Oriole Cling				*		Uneeda Cling				*	
Orleans			*			Van Meteors				*	
Ostrander Late				*		Victor	*				
O. Z. Cling				*		Waddell			*		
Parson Early			*			Wager			*		
Pearce Yellow			*			Walker				*	
Pearson			*			Ward Late				*	
Perfection				*		Washington				*	
Philip Horton					*	Waterloo	*				
Picquet					*	Weaver					*
Potter			*			Wheatland			*		
Pratt				*		Wiard			*		
Prolific			*			Wilkins				*	
Ray			*			Willard			*		
Red Bird		*				Willett				*	
Red Bird Cling		*				Williams					*
Red Cheek Melocoton			*			Wm. Lynn			*		
Reeves Favorite			*			Wonderful					*
R. S. Stevens			*			Worlds Fair	*				
Rudings Late			*			Worrell				*	
Russell			*			Wright				*	
Salway					*	Yellow Rareripe			*		
Schumaker	*					Yellow St. John		*			
Scott Nonpareil				*		Yellow Swan		*			
Sea Eagle				*							

PLUMS.

Domestica plums begin ripening at Geneva about July fifteenth: the Trifloras and Cerasiferas, July twentieth; the Munsonianas, August first; the Americanas, August twentieth; the Insititias, September first; and the Hortulanas, October first.

The season for the Domesticas covers about eighty days; Trifloras, sixty days; Cerasiferas, eight days; Munsonianas, thirty-six days; Americanas, twenty days; Insititias, thirty days; and the Hortulanas, fifteen days.

Hybrid plums show all of the variations in date of ripening and length of season to be found in the parent species.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Prunus domestica						Hand			*		
Agen				*		Hudson				*	
Althann				*		Hulings				*	
Arch Duke				*		Hungarian			*		
Arctic			*			Ickworth			*		
Autumn Compote				*		Imperial Epineuse				*	
Bavay					*	Imperial Gage			*		
Belgian Purple			*			Italian Prune				*	
Belle				*		Jefferson				*	
Bradshaw			*			Kirke			*		
Bryanston				*		Lafayette				*	
Chambourcy					*	Large English				*	
Champion		*				Late Muscatelle				*	
Clingstem				*		Late Orleans				*	
Clyman		*				Lincoln			*		
Copper					*	Lucombe			*		
Czar	*					McLaughlin			*		
Diamond			*			Middleburg					*
Duane			*			Miller Superb			*		
Early Orleans			*			Monarch				*	
Early Rivers	*					Monroe			*		
Empire			*			Newark			*		
Field			*			Orange			*		
Furst			*			Oullins		*			
German Prune				*		Pacific			*		
Golden Drop					*	Palatine				*	
Goliath			*			Paul Early	*				
Grand Duke				*		Pearl			*		
Gueii			*			Peters			*		
Guthrie Late			*			Pond				*	

	Very early.	Early.	Midseason.	Late.	Very late.
Purple Gage			*		
Quackenboss				*	
Red Date			*		
Red Magnum Bonum				*	
St. Catherine				*	
Saunders			*		
Sheldrake			*		
Shipper				*	
Smith Orleans			*		
Spaulding			*		
Tennant			*		
Tragedy		*			
Transparent				*	
Ungarish				*	
Victoria			*		
Wales			*		
Wangenheim			*		
Washington			*		
Yellow Egg				*	
Yellow Gage			*		
Prunus insititia					
Black Bullace				*	
Crittenden				*	
Drap D'Or			*		
Freestone				*	
French				*	
Frogmore			*		
Frost Damson			*		
King Damson			*		
Late Mirabelle				*	
Shropshire				*	
White Bullace				*	
Prunus cerasifera.					
De Caradeuc		*			
Golden Cherry	*				
Prunus triflora.					
Abundance			*		
Burbank			*		
Chabot				*	
Earliest of All	*				
Engre	*				
Georgeson			*		
Hale			*		
Maru			*		
Occident			*		
October					*
Red June			*		
Willard		*			
Prunus munsoniana.					
Newman			*		
Poole Pride			*		
Pottawattamie			*		
Robinson			*		
Wild Goose		*			
Prunus americana.					
De Soto			*		
Oren			*		
Rolling Stone		*			
Stoddard			*		
Weaver				*	
Wood		*			
Prunus hortulana.					
Wayland					*
World Beater				*	
Prunus hortulana mineri.					
Forest Garden			*		
Miner			*		
Surprise		*			
Prunus americana mollis.					
Wolf		*			
HYBRIDS.					
America			*		
Ames				*	
Climax			*		
Golden					*
Hammer				*	
Japex	*				
Juicy				*	
Marianna	*				
Maynard			*		
Shiro		*			
Wickson				*	

CHERRIES.

The cherry season begins at Geneva with the ripening of early Sweet cherries about June twelfth followed a week later by some of the Sour sorts while the Dukes, or hybrid cherries, are, as a group, a day or two later in beginning to ripen than Sour cherries. The length of the season for cherries is about a month and is nearly the same for the three groups though the Sour and hybrid cherries last a little longer, and may be kept considerably longer, than Sweet cherries.

	Very early.	Early.	Midseason.	Late.	Very late.
SWEET CHERRIES.					
Allen			*		
Black Tartarian		*			
Burbank				*	
Cal. Advance	*				
Centennial				*	
Cleveland			*		
Coe		*			
Dikeman				*	
Downer				*	
Eagle			*		
Early Purple	*				
Elkhorn			*		
Elton			*		
Florence		*			
Genesee				*	
Hoy			*		
Ida		*			
Kirtland		*			
Knight		*			
Lamaurie		*			
Lambert			*		
Lyons		*			
Mercer				*	
Mezel			*		
Napoleon				*	
Republican				*	
Rockport			*		
Schmidt				*	
Sparhawk			*		
Stuart				*	
Summit		*			
Windsor				*	
Wood		*			
Yellow Spanish			*		

	Very early.	Early.	Midseason.	Late.	Very late.
SOUR CHERRIES.					
Bourgueil			*		
Brusseler Braune				*	
Carnation			*		
Cole					*
Double Natte	*				
Dyehouse		*			
Early Morello			*		
Early Richmond		*			
English Morello				*	
George Glass			*		
Grosse Picarde				*	
Heart-shaped Weichsel			*		
King Amarelle		*			
Large Montmorency			*		
Louis Philippe			*		
Magnifique					*
Montmorency			*		
Northwest				*	
Olivet		*			
Ostheim			*		
Riga			*		
Short-stem Montmorency			*		
Sklanka		*			
Späte Amarelle			*		
Suda					*
Timme			*		
Tubbs			*		
Vladimir				*	
HYBRID CHERRIES.					
Abbesse d'Oignies			*		
Bender (of New York)					*

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
HYBRID CHERRIES (*continued*):						New Century	...	...	*	...	...
						Nouvelle Royale	...	...	*	...	...
Empress Eugenie	...	*	...	...	...	Reine Hortense	...	...	*	...	...
Late Duke	...	...	...	...	*	Royal Duke	...	...	*	...	...
May Duke	...	*	...	...	...						

GRAPES

During the last three years the earliest season was 1913, the first grape being marked ripe on the first of September while in 1912 the first was ripe on the twelfth. The first week in October usually marks the height of the season at Geneva although in 1912 it was in the second week. The season of 1913 was an unusually long one allowing most of the very late grapes to ripen. The last record was taken October twenty-seventh. Usually killing frosts during the second or third week in October cut off many of the latest sorts. This is especially true when ripening is delayed by cool weather as in 1914.

For a number of years as the grapes were picked they were placed in common storage. The room was on the second floor so that conditions were not ideal and the season of storage could probably have been prolonged considerably if a basement room could have been used. The figures given cover a variable number of years for the different varieties.

	Weeks in common storage.	Very early.	Early.	Midseason.	Late.	Very late.		Weeks in common storage.	Very early.	Early.	Midseason.	Late.	Very late.
Adirondac	14	...	*	...	...	...	Amethyst	12	...	...	*	...	...
Agawam	27	...	...	...	*	...	Aminia	25	...	*	...	...	...
Alexander Winter	8	...	...	*	...	...	Antoinette	6	...	*	...	...	...
Alice	16	...	...	...	*	...	Arkansas	7	...	...	*	...	...
Amber Queen	16	...	...	...	*	...	Aroma	...	...	...	...	*	...
Ambrosia	12	...	*	...	...	...	August Giant	15	...	...	...	*	...
America	7	...	*	...	...	...	Bacchus	20	...	...	...	*	...

	Weeks in common storage.	Very early.	Early.	Midseason.	Late.	Very late.		Weeks in common storage.	Very early.	Early.	Midseason.	Late.	Very late.
Bailey	12	...	...	...	*	...	Faith	11	...	...	*	...	...
Banner	15	...	...	...	...	*	Fern Munson	11	...	...	...	...	*
Barry	28	...	...	*	...	...	Gaertner	17	...	...	*	...	...
Beacon	7	...	...	*	...	...	Garfield	11	...	*	...	...	...
Bell	8	...	*	...	...	...	Geneva	22	...	*	...	...	...
Berckmans	21	...	...	*	...	...	Glenfeld	9	...	...	...	*	...
Bertha	6	...	...	...	*	...	Goethe	18	...	...	...	...	*
Big Hope	5	...	...	...	*	...	Goff	19	...	...	...	*	...
Black Eagle	18	...	...	*	...	...	Gold Coin	10	...	...	...	*	...
Bridgewater	6	*	...	...	...	...	Golden Drop	23	...	*	...	...	...
Brighton	20	...	...	*	...	...	Gold Dust	8	...	...	*	...	...
Brilliant	11	...	...	*	...	...	Golden Grain	6	...	...	...	*	...
Brown	6	...	...	*	...	...	Green Early	10	...	...	*	...	...
Campbell Early	12	...	*	...	...	...	Grein Golden	12	...	...	...	*	...
Canada	17	...	...	...	*	...	Hartford	8	...	...	*	...	...
Canandaigua	20	...	...	...	*	...	Headlight	8	*	...	...	...	...
Captain	8	...	...	*	...	...	Helen Keller	26	...	...	...	*	...
Captivator	...	*	...	...	...	...	Herbert	27	...	...	*	...	...
Carman	17	...	...	*	...	...	Hercules	13	...	...	...	*	...
Catawba	21	...	...	...	...	*	Hernito	...	...	...	*	...	...
Cayuga	11	...	*	...	...	...	Hexamer	6	...	...	...	*	...
Champion	6	...	*	...	...	...	Hicks	10	...	...	*	...	...
Champanel	15	...	...	...	*	...	Hidalgo	12	...	...	*	...	...
Chambril	11	...	...	*	...	...	Hopican	15	...	...	...	*	...
Chandler	10	...	...	*	...	...	Hopkins	5	...	...	...	*	...
Chautauqua	10	...	...	...	*	...	Hosford	6	...	...	...	*	...
Clevener	13	...	...	...	*	...	Hubbard Seedless	6	...	...	*	...	...
Clinton	21	...	...	...	...	*	Hybrid Franc	8	...	...	...	...	*
Cloeta	10	...	...	...	*	...	Illinois City	9	...	...	*	...	...
Cochee	6	...	...	...	*	...	International	14	...	...	...	*	...
Colerain	8	...	...	*	...	...	Iona	13	...	...	...	*	...
Columbian Imperial	7	...	...	...	*	...	Isabella	11	...	...	*	...	...
Collier	5	...	...	...	*	...	Janesville	13	...	...	*	...	...
Concord	8	...	...	*	...	...	Jefferson	18	...	...	...	...	*
Corby	10	...	...	*	...	...	Jessica	12	...	*	...	...	...
Cottage	5	...	*	...	...	...	Jewel	12	...	*	...	...	...
Creveling	16	...	*	...	...	...	Kensington	19	...	...	...	*	...
Croton	23	*	...	...	...	...	Kentucky	...	...	...	...	...	*
Daisy	10	...	*	...	...	...	King	...	...	*	...	...	...
Delakins	20	...	...	...	*	...	Krause	11	...	...	*	...	...
Delago	25	...	...	...	...	*	Laconia	14	...	...	...	*	...
Delaware	15	...	*	...	...	...	Lady Washington	16	...	...	...	*	...
Diamond	10	...	*	...	...	...	L'Amoreaux	5	...	...	*	...	...
Diana	17	...	...	...	...	*	Leader	5	...	...	*	...	...
Downing	...	...	...	...	*	...	Lindley	27	...	...	*	...	...
Dracut Amber	9	...	*	...	...	...	Lindmar	11	...	...	*	...	...
Dry Hill Beauty	6	...	*	...	...	...	Linn	11	...	...	...	...	...
Dutchess	23	...	...	*	...	...	Livingston	15	...	...	*	...	...
Early Dawn	13	...	*	...	...	...	Little Blue	5	...	*	...	...	...
Early Golden	13	...	...	*	...	...	Long John	5	...	...	...	...	*
Early Ohio	...	*	...	...	...	...	Lucile	9	...	...	*	...	...
Early Victor	11	*	...	...	...	...	Lutie	4	*	...	...	...	...
Eaton	6	...	...	...	*	...	McPike	7	...	...	*	...	...
Eclipse I	7	*	...	...	...	...	McKinley	9	...	*	...	...	...
Eclipse II	7	...	...	*	...	...	Mabel	19	...	...	*	...	...
Eldorado	17	*	...	...	...	...	Magnate	9	...	...	...	*	...
Elsinburgh	9	...	...	*	...	...	Mammoth	11	...	...	...	*	...
Elvibach	19	...	*	...	...	...	Manito	7	...	...	...	*	...
Elvira	18	...	...	*	...	...	Mary Favorite	14	...	...	*	...	...
Emerald	10	...	...	*	...	...	Marie Louise	6	...	*	...	...	...
Empire State	24	...	...	...	*	...	Marion	14	...	...	*	...	...
Essex	22	...	...	...	...	*	Martha	10	...	...	*	...	...
Etta	15	...	...	...	...	*	Marsala	5	...	*	...	...	...
Eumedel	15	...	*	...	...	...	Massasoit	16	...	...	*	...	...
Eumelan	17	...	*	...	...	...	Maxatawney	12	...	...	*	...	...
Extra	10	...	...	...	*	...	Merrimac	31	...	...	*	...	...

	Weeks in common storage.	Very early.	Early.	Midseason.	Late.	Very late.
Mills	29	...	...	...	*	...
Missouri Riesling	6	...	...	...	*	...
Montefiore	9	...	...	*	...	...
Montclair	15	...	...	...	*	...
Moore Early	6	*	...	...	...	...
Moyer	9	...	*	...	...	...
Munson	......	...	...	*	...	...
Nectar	10	...	*	...	...	...
Neosho	6	...	...	...	*	...
Newburgh Muscat	20	...	...	...	*	...
Niagara	10	...	*	...	...	...
Noah	10	...	...	*	...	...
Norfolk	6	...	...	*	...	...
Northern Muscadine	9	...	...	*	...	...
Norton	7	...	...	...	...	*
Occidental	18	...	...	...	*	...
Olita	12	...	...	*	...	...
Omega	6	...	...	*	...	...
Oneida	18	...	...	...	...	*
Oporto	12	...	...	*	...	...
Osage	10	...	*	...	...	...
Ozark	11	...	...	...	*	...
Palermo	13	...	...	...	*	...
Paradox	13	...	...	*	...	...
Paragon	7	...	...	...	*	...
Peabody	......	...	...	...	*	...
Pearl	12	...	...	...	*	...
Perfection	8	...	...	*	...	...
Perkins	......	...	...	...	*	...
Pierce	12	...	...	...	*	...
Pocklington	......	...	*	...	...	...
Poughkeepsie	15	...	*	...	...	...
Prentiss	16	...	...	...	*	...
President	......	...	...	*	...	...
Presley	7	*	...	...	...	...
Pukwana	5	...	...	...	*	...
Pulaski	5	...	...	*	...	...
Pulliat	10	...	...	...	*	...
Purity	16	...	...	*	...	...
Rebecca	18	...	...	*	...	...
Red Bird	5	...	*	...	...	...
Red Eagle	13	...	*	...	...	...
Red Rover	20	...	...	*	...	...
Red Riesling	14	...	...	...	...	*
Regal	16	...	...	...	*	...
Requa	30	...	...	*	...	...
Rochester	7	...	...	*	...	...
Rockwood	11	*	...	...	...	...
Rommel	10	...	...	*	...	...
Rupert	8	...	...	...	*	...
Rustler	12	...	...	*	...	...
R. W. Munson	5	...	...	...	*	...
St. Hilaire	19	...	...	...	...	*
St. Louis	11	...	...	*	...	...
Salem	27	...	...	...	*	...
Sanbornton	14	...	...	*	...	...
Santa Clara	6	*	...	...	...	...
Secretary	25	...	...	...	*	...
Senasqua	13	...	...	...	*	...
Shelby	9	...	*	...	...	...
Standard	14	...	...	*	...	...
Stark-Star	10	...	...	...	...	*
Sterling	......	...	...	*	...	...
Sunrise	5	*	...	...	...	...
Superb	18	...	...	*	...	...
Telegraph	8	...	...	...	*	...
Tonkawa	9	...	...	*	...	...
Triumph	15	...	...	...	...	*
Ulster	21	...	...	...	*	...
Vergennes	28	...	...	...	*	...
Victoria	8	...	...	*	...	...
Waldo	9	...	*	...	...	...
Wapanuka	7	...	*	...	...	...
Western Beauty	18	...	...	...	*	...
Wheaton	12	...	*	...	...	...
White Imperial	9	...	...	*	...	...
Wilder	11	...	...	...	*	...
Willard	18	...	...	*	...	...
Winchell	6	*	...	...	...	...
Wine King	4	...	...	...	*	...
Worden	6	...	*	...	...	...
Wyoming	9	...	*	...	...	...

GOOSEBERRIES.

Gooseberries are picked in various stages of greenness so that ripening dates for them mean less than with other fruits. As we come to know the European sorts better, the demand for ripe gooseberries will increase and the information in the following table, made up for most part of English sorts, will become more valuable. Gooseberries begin ripening at Geneva about July first and continue to ripen from ten to fifteen days. The berries of some European kinds remain on the bushes in edible condition for from ten to twenty days after ripening.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Antagonist			*			Leigh			*		
Berkeley				*		Leveller				*	
Blucher			*			Lord Beaconsfield				*	
Candidate			*			Matchless			*		
Careless	*					May Duke	*				
Carrie			*			Monument				*	
Carman			*			Oregon				*	
Catherine			*			Oskender Bey			*		
Chautauqua			*			Overall			*		
Dominion			*			Ozonne				*	
Downing			*			Pearl			*		
Drill			*			Poorman		*			
Duke of Sutherland			*			Portage				*	
Duplication			*			Queen of Whites		*			
Early Hedgehog				*		Red Champagne				*	
Freedom		*				Red Warrington				*	
Galopin			*			Rough Yellow Scotch		*			
General				*		Smith			*		
Gipsy Queen				*		Smiling Beauty			*		
Golden Prolific	*					Stockwell		*			
High Sheriff			*			Succeed					*
Houghton			*			Sulphur		*			
Industry		*				Sunset				*	
Jolly Angler				*		Tally Ho				*	
Josselyn		*				Thumper		*			
Keepsake		*				Victoria			*		
King of Trumps				*		Wellington			*		
Lady Houghton			*			White Eagle					*
Lady Popham		*				Whitesmith		*			
Lancashire Lad			*								

CURRANTS.

Currants begin ripening at Geneva the last week in June and the varieties succeed each other during a period of three weeks. Currants hang on the bushes for a week or two after maturity without great deterioration.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Black Victoria			*			Champion				*	
Boskoop Giant			*			Chautauqua			*		

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Cherry		*				Perfection		*			
Comet			*			Pomona		*			
Crandall					*	Prince Albert				*	
Diploma			*			Red Cross			*		
Fay			*			Red Dutch			*		
Filler			*			Ruby		*			
Franco German				*		Versailles			*		
Holland				*		Victoria			*		
Lee				*		White Dutch		*			
London Market			*			White Imperial			*		
Magnum Bonum			*			White Grape			*		
Naples					*	White Transparent		*			
North Star		*				Wilder			*		

BLACKBERRIES AND DEWBERRIES.

The blackberries in the following list begin ripening about July fifteenth and the dewberries a few days earlier. The season for these two fruits lasts from 20 to 30 days.

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Agawam			*			Mersereau			*		
Blowers			*			Minnewaska			*		
Briton				*		Ohmer			*		
Early Harvest	*					Premo (Dewberry)	*				
Eldorado			*			Rathbun			*		
Erie			*			Snyder			*		
Giant Himalaya					*	Sorsby May				*	
Joy					*	Taylor			*		
Kenoyer	*					Ward				*	
Kittatinny			*			Wilson		*			
Lucretia (Dewberry)	*					Watt			*		
McDonald (Dewberry)	*										

RASPBERRIES.

The Red raspberry season begins with the ripening of the extra early Station seedling, June, which is usually ready for picking the last week of June. The hybrid sorts, or Purple Canes, and the Yellow raspberries, come on about July twelfth; while Black raspberries start their season the first week in July. The season for the Red and hybrid raspberries is from fifteen to twenty days; for the Black raspberries, from ten to fifteen days.

	Very early	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
RED AND HYBRID RASPBERRIES.						Syracuse				*	
						Turner				*	
Brilliant			*			Twentieth Century				*	
Buckeye				*		Watson			*		
Columbian (Purple)				*							
Cuthbert			*			**BLACK RASPBERRIES.**					
Donboro			*			Black Pearl		*			
Eaton			*			Cumberland				*	
Golden Queen				*		Diamond			*		
Haymaker (Purple)					*	Eureka		*			
Herbert				*		Gault				*	
Idaho			*			Gregg					*
June	*					Hilborn				*	
Marlboro		*				Hoosier			*		
Marldon			*			Johnson Sweet				*	
Miller			*			Kansas			*		
Minnetonka				*		Mammoth Cluster		*			
Perfection	*					Midwest			*		
Red Antwerp				*		Ohio				*	
Royal Purple (Purple)					*	Palmer		*			
Ruby			*			Plum Farmer			*		
Ranere (St. Regis)		*				Rachel					*
Segrist				*		Souhegan		*			
Shaffer (Purple)				*		Stone Fort			*		
Surprise			*			Winfield			*		

STRAWBERRIES.

Strawberries may be expected to begin ripening at Geneva about June twelfth and the season to last from fifteen to twenty days. With the fall-bearing sorts there is, of course, a second bearing period of approximately a month beginning about the middle of September

	Very early.	Early.	Midseason.	Late.	Very late.		Very early.	Early.	Midseason.	Late.	Very late.
Abington			*			**Gov. Fort**				*	
Amanda			*			**Gov. Rollins**		*			
Americus				*		**Granger**			*		
Atkins Continuity	*					**Grand Marie**		*			
Autumn				*		**Gray Dollar**			*		
Baltimore			*			**Greenwood**				*	
Barkley		*				**Helen Davis**			*		
Barrymore			*			**Highland**		*			
Battenburg			*			**Hub**			*		
Bederwood		*				**Hughson**		*			
Berlin				*		**Indiana**			*		
Bethel			*			**Ionia Market**		*			
Black Beauty			*			**Iowa**	*				
Bradley			*			**Irena**		*			
Brandywine			*			**James Todd**			*		
Big Rock			*			**Joe**				*	
Bull Moose			*			**July**			*		
Buster			*			**Kevitt Wonder**			*		
Carrie Silvers			*			**Killarney**				*	
Chesapeake			*			**Kittie Rice**		*			
Clara			*			**Klondike**				*	
Climax	*					**Labell**					*
Columbia				*		**Latest of All**					*
Consort			*			**Late Jersey Giant**				*	
Corinne			*			**Laxton Latest**			*		
Danby			*			**Lea**	*				
Darlington			*			**Magnus**			*		
Dawley			*			**Manhattan**				*	
Deacon			*			**Marshall**			*		
Dewdrop				*		**Maryland Prize**			*		
Dicky			*			**Mascot**				*	
Dighton		*				**Matthew Crawford**					*
Dixon			*			**Maud Muller**		*			
Dunmore		*				**Meteor**				*	
Dunlap		*				**Missionary**		*			
Early Jersey Giant		*				**Model**			*		
Early Ozark		*				**Monroe**		*			
Early Queen			*			**Myer**		*			
Ekey			*			**Nanticoke**		*			
Ernest			*			**Nettie**				*	
Fillbasket					*	**New Discovery**			*		
First Prize		*				**Norwood**			*		
First Quality				*		**Ohio Boy**			*		
Four Seasons				*		**Omega**					*
Glastonbury			*			**Orem**					*
Golden Gate			*			**Orphan**					*
Goodell			*			**Outlander**					*
Good Luck			*			**Pan American**	*				
Goodwin			*			**Parcell Early**	*				
Goree			*			**Patagonia**					*

	Very early.	Early.	Midseason.	Late.	Very late.
Paul Jones			*		
Peach			*		
Peckham Wonder			*		
Phoenix				*	
Posey			*		
Productive				*	
Prof. Fisher					*
Progressive		*			
Prolific			*		
Quality				*	
Red Bird		*			
Red Prolific			*		
Repeater		*			
Rose Ettersburg					*
Rough Rider			*		
Saint Fiacre		*			
Saint Joseph	*				
Sample				*	
Saratoga			*		
Sherman			*		
Silver Coin			*		
Sons Prolific			*		
Stevens Great American			*		
Stevens (Late Champion)					*
Superb			*		
Superior		*			
Swedenberg		*			
Sweetheart			*		
Townsend Late Champion				*	
Twilley				*	
Uncle Sam	*				
Walnut Stump					*
W. H. Taft			*		
Winner			*		
Wooster		*			

NEW OR NOTEWORTHY FRUITS. III.*

U. P. HEDRICK.

INTRODUCTION.

This is the third report on new or noteworthy fruits from the New York Agricultural Experiment Station. The objects of these reports are, in a word, to describe the best recent fruit introductions and to call attention to noteworthy sorts, which, though old, have not received the attention they deserve. The statement was made and discussed at greater or less length in the first two reports, that without new varieties fruit growing would be at a standstill since old varieties have not been, and probably can not be, improved. This fact might well be further emphasized but it seems more important in this third discussion of new varieties to set forth, in the introductory remarks, the relative value of new and standard varieties of fruits for commercial planting. For, it is to be feared, from the correspondence that has followed, that the varieties described in the first two bulletins on new fruits have not been viewed in the right perspective by some readers.

The tendency on the part of many commercial fruit growers is to plant at once largely of the sorts recommended as promising in this series of bulletins. It would seem from this that the description and illustration of a new variety of fruit in a Station publication sometimes invests it with a value that does not belong to it. Seemingly, for some, such a publication puts a premium on uniqueness, rarity and scarcity. Beginners, especially, in fruit growing, regard uniqueness and rarity as elements of intrinsic worth in a variety. They are prone to believe that that which is common is not desirable. In particular, men from the city, accustomed to the fancy fruits of the delicatessen stores, who go into commercial orcharding, feel that commonness is a reproach to a variety and set out to grow aristocratic fruits. With such men enthusiasm receives a setback when standard sorts are recommended.

Now, just the converse is true, in commercial orchards at least. The demand in the market is for common and well-known fruits and no matter what the merit of a new fruit may be, it is often difficult to market it advantageously. Consumers want common commodities and not rarities. Keeping in mind, of course, that the different varieties have different values in accordance with the use to which they are put, it is safe to generalize and say that the standard sorts of all fruits have the highest value for both home and market plantations.

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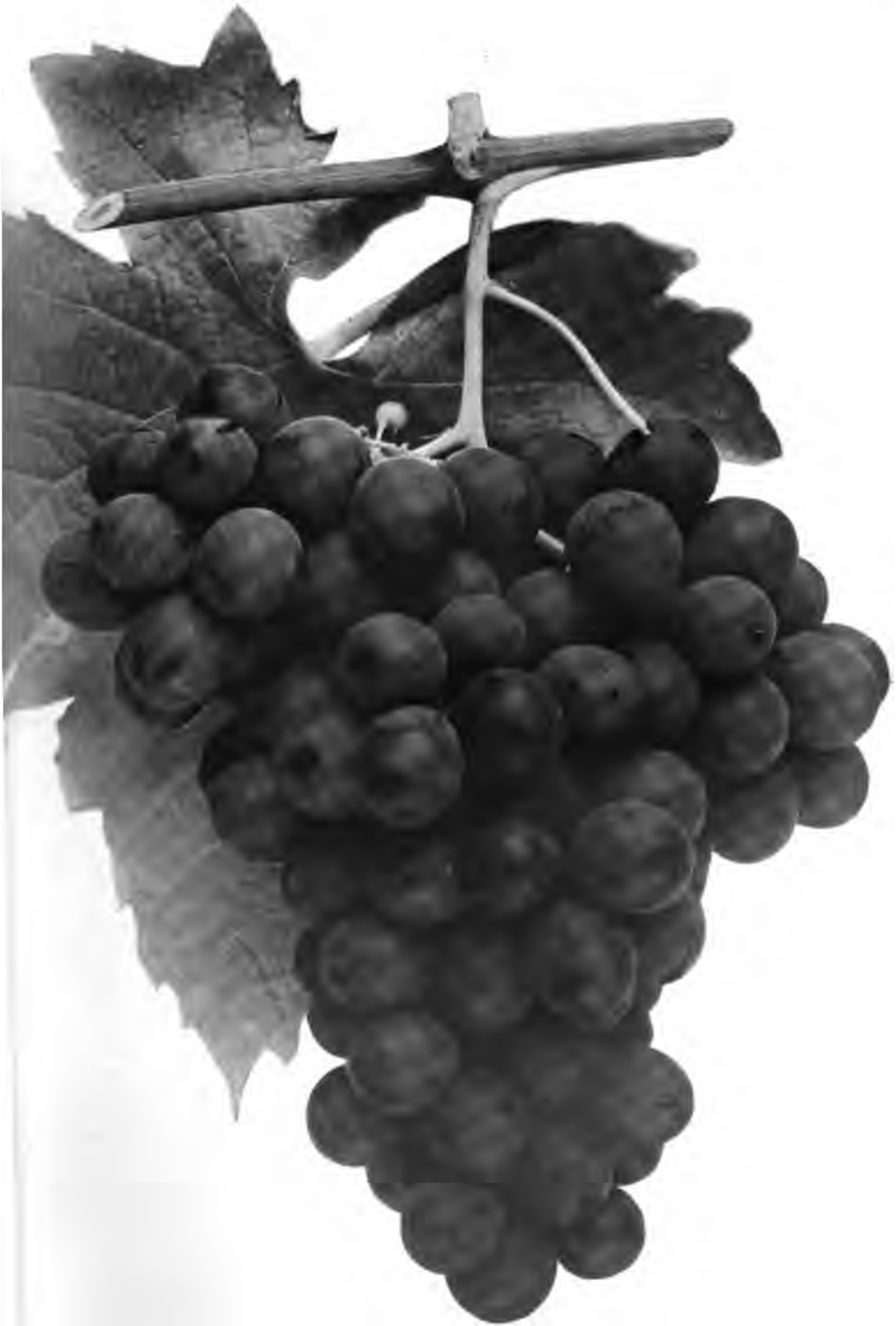
* A reprint of Bulletin No. 403, April, 1915.

A new variety must be looked upon as a speculation, an experiment, a "flyer in futures." A commercial fruit grower should let new varieties stand the test of time, demonstrate their value — in other words become "standard" — before planting them extensively. Whatever the fruit, it is a truism to which there are but few exceptions that standard varieties should form the basis of every good commercial plantation. Here, commonness is no reproach. A few plants of a few new varieties will do no harm. It is good business and perhaps a duty of every progressive fruit grower to try some new sorts; but an orchard made up wholly of new varieties is an unsatisfactory lot of incongruities, as the fruit plantation at every experiment station bears witness.

What has been said must not be taken as a condemnation of new varieties. Such an attitude would be unjust — would be setting oneself against progress. The purpose of these introductory remarks must not be mistaken. We aim only to protest against the idea, now quite too common, that new varieties in large numbers should be set in commercial orchards with the hope that their rarity and possibly some new and wonderful characters that they possess will make them more profitable than the standard sorts. Despite the many new fruits, Baldwin, Bartlett, Elberta, Montmorency, Napoleon and Bradshaw are still the most valuable varieties of tree fruits for commercial planting in New York; and, similarly, speaking generally, the most profitable small fruits are those that have a reputation as money-makers.

It is quite another thing for connoisseurs and amateur fruit growers to plant new varieties. They grow fruit for the love of the work. To them the orchard often exists for the new and rare things that they can put in it. Such fruit growing is a pleasant diversion and, in a broad way, a profitable one, through the knowledge obtained of varieties, for all planters of fruit. It is readily comprehensible that connoisseurs and amateurs want all of the promising new varie-



MUSCAT HAMBURG
(ONE-HALF NATURAL SIZE)

UNIV. OF MICH.

ties. We care not how much the discussion of new fruits may kindle the admiration and awaken the passion for collecting in the connoisseur. The appeal in this case is to the palate and to the aesthetic senses and not to the pocketbook.

The publication of these reports on new fruits is bringing up another matter for discussion. Many fruit growers want to plant new varieties in greater or less numbers but object to the high price asked by nurserymen for novelties. This is unjust to the nurserymen. It costs much to buy or breed a new variety, propagate it and get it on the market. In particular, it is expensive to advertise the merits of a new horticultural product in these days when descriptions are pitched in the high key which nurserymen use in singing the praises of their wares. It should be expected, too, that varieties which are new and scarce will cost more than those long and commonly propagated. This is but obedience to the law of supply and demand. For these reasons a nurseryman has a right to levy toll on the fruit grower through a higher price for recent introductions.

With the mild caution to fruit growers, then, to make haste slowly in planting commercially the promising new fruits of these bulletins, we pass to the task of describing several of the most worthy fruits now on probation at this Station. Before doing this, however, it may be well to state the number of fruits competing in the test with those here described. In its effort to try every fruit offered by American nurserymen suited to New York, this Station was growing, in 1914, varieties in number as follows: Apples, 412; pears, 276; quinces, 18; peaches, 394; nectarines, 34; apricots, 47; plums, 296; cherries, 99; grapes, 404; currants, 33; raspberries, 70; blackberries, 41; gooseberries, 63; strawberries, 114; total number of named varieties, 2,301.

PEACH.

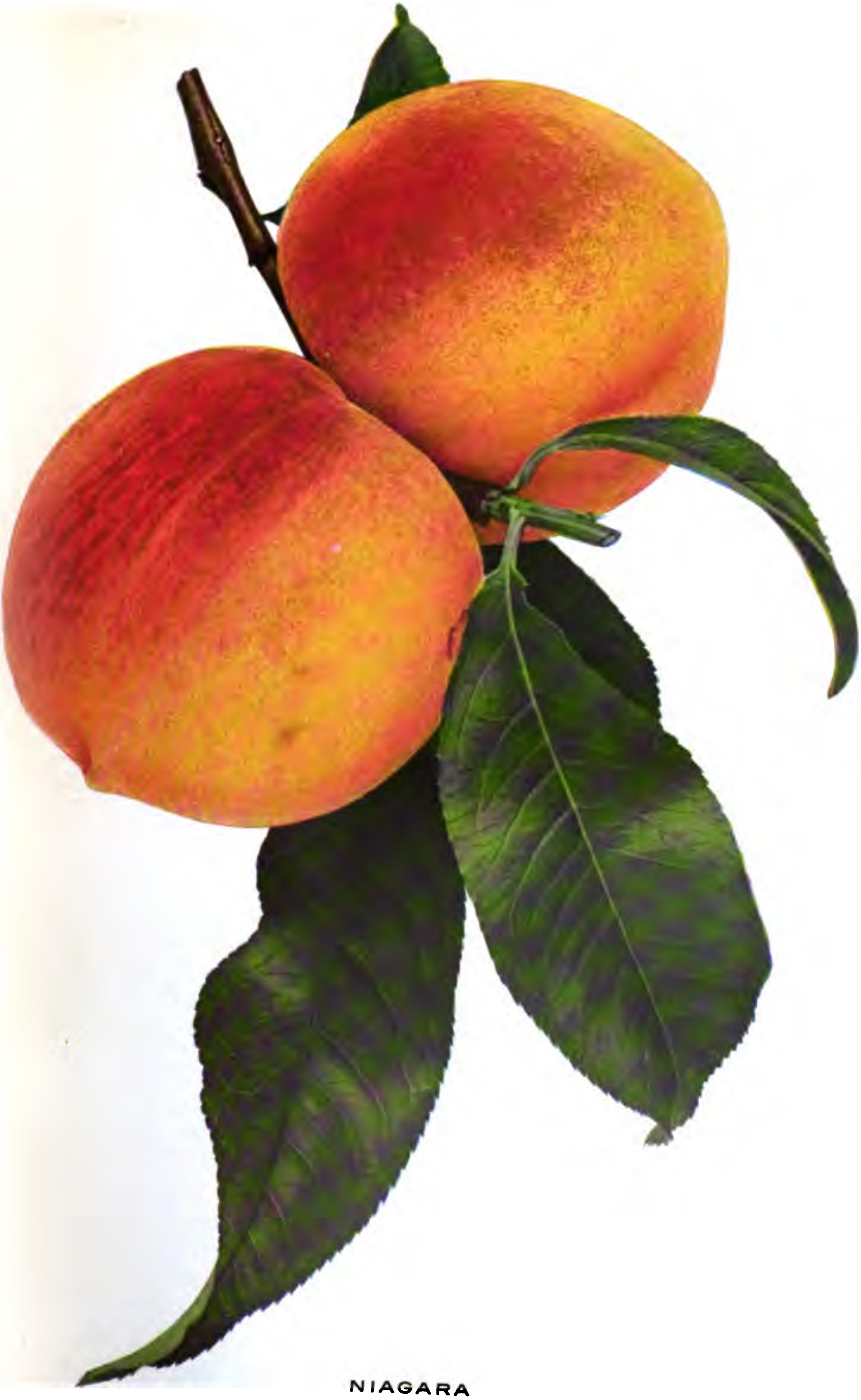
Niagara is a variant of a peach which all growers lament as being less and less grown, the Crawford. The Crawford group, though a dominant type, is a little too capricious as to soil and climate to suit the needs of commercial peach growers, failing to bear regularly or abundantly in any but choicely good peach soils. For this reason the once very popular Early and Late Crawfords are now seldom grown. All who have known these varieties and others of their group regret that a sort of their type, without their failings, has not yet come to light. In New York the best of the comparatively new Crawford-like peaches is the Niagara, said to be a seedling of one of the Crawfords. It ripens a little later than Early Crawford, averages rather larger, is borne more abundantly and holds its size better to the end of the season; but its great point of merit, as compared with other Crawfords, is that it is more dependable in all tree-characters, being especially less capricious as to soil and climate. Niagara, as the color plate shows it, is a beautiful fruit, yellow, with a handsome over-color of red. The flesh, too, is very attractive — yellow, thick and firm, with a rich, sweet flavor which makes it one of the most palatable peaches of its season. It is, as are most of its type, a freestone. Niagara is liable to fail in productiveness in some localities, having in this respect the fault of all its tribe; but it should have a welcome place in any home collection and, where it proves productive, is one of the best for general market.

Niagara probably came originally from Maryland to Julius Harris of Ridgeway, New York. Later, it was sold to a grower near Lockport, New York, who disposed of it to a Mr. Corwin of Newfane, Niagara County, New York, who called it Corwin's Crawford. It then came into possession of the Rogers Nurseries, Dansville, New York, from whom this Station received its trees under the name of Niagara.

Tree large, upright, productive; branches stocky, reddish-brown mingled with ash-gray; leaves six and three-fourths inches long, one and three-fourths inches wide, broad-oval to obovate, dull, dark green, rugose; flower buds large, long, conical; flowers one inch across, pale pink. Fruit matures early in September; a little smaller than Elberta, roundish-cordate, somewhat compressed, halves nearly equal; cavity deep, wide; suture shallow; apex pointed or rounded; color greenish-yellow becoming orange-yellow with stripes and splashes, often becoming dark, dull red over a speckled ground of lighter red forming a deep, dull blush; pubescence short, thick; skin thick, tough, adherent to the pulp; flesh yellowish, tinged with red at the pit, juicy, tender, sweet and rich; good in quality; stone free.

GRAPE.

Muscat Hamburg is a European grape well known in some parts of America in greenhouse graperies since it is the best of its kind for forcing. All horticulturists had come to believe that it is impossible to grow varieties of the exotic *Vitis vinifera* out of doors in eastern America but experiments at this Station during the last six years with over a hundred varieties of this foreign fruit



NIAGARA

UNIV. OF MICH.

show that, when grafted on roots resistant to phylloxera, sprayed for fungi and given some protection in the winter, many European grapes can be well grown in New York. Among the best of these is the Muscat Hamburg. All who know the beautiful fruits of this variety grown in the forcing houses will want to test this variety out of doors, where they have done, at this Station, scarcely less well than indoors, many clusters attaining the weight of a pound and a half to two pounds. The accompanying color plate, the fruit much less than half the natural size, shows what a splendid grape Muscat Hamburg is in our vineyards. One is struck with wondering admiration at a vine laden with these grapes growing alongside Concord, Niagara or Delaware. The quality is most delectable — the quintessence of the flavors and aromas which make the grape a favorite fruit. The grapes keep long and retain their form, size, color and rich, delicate flavor almost to the end. This variety should prove a treasure to the amateur; and the professional who wants another grape for local market should try grafting over a few vines of some native to this European sort. This having been done, he must keep down fungi by spraying and protect the vines in the fall by bending them over and covering lightly with earth. With this simple treatment almost anyone who can grow vines may enjoy the luxury of greenhouse grapes grown out of doors.

The variety is an old one, long known in Europe and one of the most highly esteemed for growing under glass. It has many synonyms but is well known by growers of European grapes under the name of this discussion.

Vine vigorous, tender, needs protection during the winter, productive; canes long, numerous, slender to medium, light brown, darker at the nodes which are enlarged and flattened; leaves medium to large, intermediate in thickness; upper surface light green, dull; lower surface pale green, faintly pubescent, densely hairy. Fruit ripens in early October, ships and keeps well; clusters very large, long, broad, tapering, single or double-shouldered. Berries large, firm, oval, very dark purplish-red, covered with lilac bloom, very persistent; skin thick, adheres strongly to the pulp; flesh pale green, translucent, meaty, very juicy, tender, vinous, musky, sweet, rich, very good to best; seeds separating easily from the pulp, large.

CHERRY.

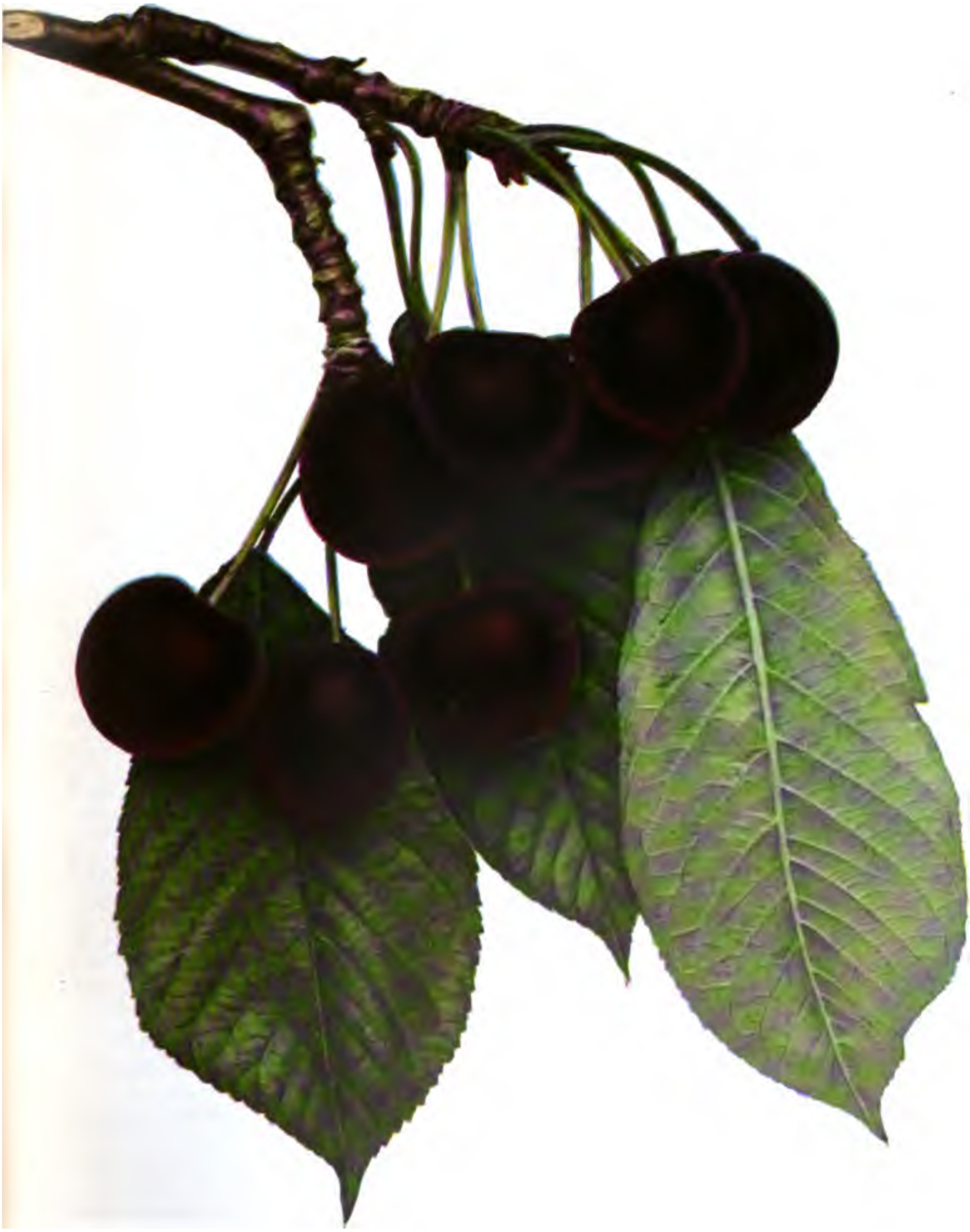
Lambert originated in Oregon and is now a standard variety in its native State but is still on probation in eastern America. It is a Bigarreau, a seedling of Napoleon by Black Heart, and a worthy rival of its parents in most respects and superior in some. In appearance Lambert is more like Black Heart than Napoleon, having much the same shape and color as the first named, but is larger, more rotund, smoother and brighter — one of the handsomest of the dark-colored Sweet Cherries. The flesh and flavor leave little to be desired. The flesh is purple-red, marbled with lighter red, firm, meaty and juicy, with a sweet but pleasantly acidulous, rich flavor that at first taste one marks as good. It is, too, very good in cookery. The tree is strong, vigorous, healthy, and usually fruitful and regular in bearing. The fruit hangs in great, loose clusters, often a dozen or more cherries to a fruit-spur. The leaves are remarkably large and dark green, the foliage betokening the vigor of the variety. Tree and fruit elicit praise from all admirers of orchard products. Lambert is well worth testing for either home or market, wherever Sweet Cherries can be grown. It is to be hoped that it finds a congenial soil and climate in many parts of New York.

Lambert originated as a seedling under a Napoleon tree which was planted by the late Henderson Lewelling about 1848 in the orchard of J. H. Lambert, Milwaukee, Oregon. A Black Heart tree stood near the Napoleon and is supposed to be the other parent of the Lambert. The seedling was grafted to May Duke and later transplanted. About 1880 the top died and a sprout from the seedling stock formed a new top. This sprout was the origin of the Lambert.

Tree medium to large, upright-spreading, very productive; branches smooth, dull reddish-brown, with numerous lenticels; leaves large, oval to obovate, thin; blooming season short, intermediate in time; flowers large, one and one-fourth inches across, borne usually in twos. Fruit matures in mid-season; one inch in diameter, roundish-cordate, compressed; cavity rather deep; color very dark red changing to reddish-black; stem tinged with red, slender, long, adherent to the pulp; flesh dark red, with scant, dark red juice, meaty, firm, pleasant flavored, sweet; very good in quality; stone clinging, large, wide, ovate.

PLUM.

The **Late Muscatelle** plum was imported from Germany in 1900 by the United States Department of Agriculture and was soon after obtained by the Geneva Station for testing. It has been fruiting for ten years on our grounds and has come to be regarded as one of the best late plums out of the 500 or more that have been



LAMBERT

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fruited with it. The plums are large, roundish and somewhat truncate, giving the fruits a pleasingly rotund shape. In color the plums are a beautiful purple-brown, slightly splashed and mottled with russet. The skin is thicker and tougher than one wishes in a first-class dessert plum but on the other hand these qualities are valuable assets in shipping. The flesh is tender, meaty, firm, juicy, sweet and delicious, characters that give the variety high rank in quality among all plums. Another pleasing characteristic is that the flesh is about the freest from the stone of all plums. As a culinary fruit it can hardly be surpassed. Late Muscatelle is one of the latest to ripen and keeps well, but if kept too long the fruit shrivels somewhat. The trees are hardy and relatively free from insects and diseases, but on the grounds of the Station are not quite as vigorous as one could wish. For home use and local market trade, Late Muscatelle is certain to prove a valuable variety and it may have a place for the general market.

Of the history of this plum we can say little beyond that it is an old European sort having several synonyms in the pomologies of continental Europe. In Germany, in particular, it seems to be highly esteemed and widely distributed.

Tree medium in size and vigor, upright-spreading, dense-topped, hardy, productive; branches numerous; leaves of medium size, thickness and color, slightly pubescent; flowers appearing after the leaves, blooming in mid-season, one inch across, usually in pairs. Fruit matures the latter part of September; medium to large in size, roundish, slightly truncate, halves nearly equal; color purplish-brown, speckled and splashed about the base with russet; stem of medium thickness and length, adhering strongly to the fruit; skin rather tough, separating readily from the pulp; flesh greenish-yellow, juicy slightly stringy, firm, pleasant flavored, aromatic, sweet; good to very good; stone small, free, reddish.

GOOSEBERRY.

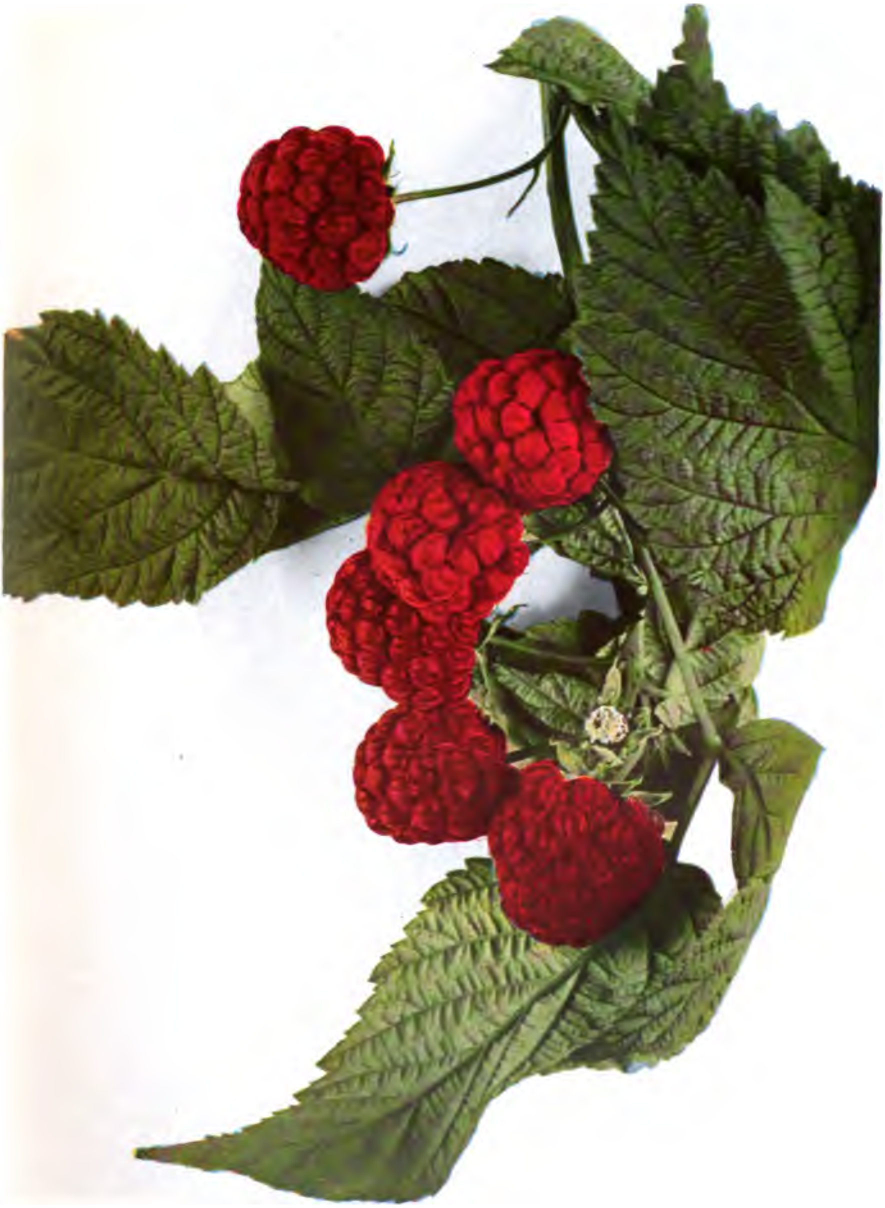
Industry is an old and noteworthy English gooseberry which receives notice in this bulletin because it is the most popular in this country of all the English kinds. It is in demand for home use, by canneries, and in the open market. The bushes are strong, stocky, vigorous growers and are among the most productive in America of all the English gooseberries. The habit of the bush, character of foliage and shoots and appearance of the fruit are distinctly European. The greatest fault with this, as with all English varieties, is the tendency to mildew, but for the past eight years both plants and fruit have been remarkably free from disease on the grounds of this Station. The berries are of large size, roundish-oblong, slightly hairy and when mature are a rather attractive dark red, the fully ripe berries ranking high in quality. The fruit, when grown for the cannery, is usually harvested before the red tinge makes its appearance. In seasons of intense sunshine the berries may scald on the bushes. It is surprising that gooseberry growers have not more generally planted this variety.

Industry was first grown by Robert Wyndham in northern England early in the Nineteenth Century. It was disseminated in this country by Ellwanger & Barry, Rochester, New York, about 1885 and at the present time is listed by nearly all nurserymen.

Bushes large with age, vigorous, stocky, upright, hardy, productive; canes and branches thick, compact, dark brownish-red nearly entirely covered with grayish scarf-skin, the younger wood lighter in color; spines long, numerous. Leaves cordate to obovate, thick, dark, glossy green, with broadly crenate margins. Flowers large, in ones and twos. Fruit matures early in July; large, roundish-oblong, attractive, dark but rather dull wine red, slightly hairy, with thin, tough skin; flesh juicy, firm, sweet and pleasantly flavored at full maturity; very good in quality.

RASPBERRIES.

Black Pearl is the most promising of the new varieties of black raspberries fruiting on the Station ground in 1914. It has not been tested long enough to recommend it unqualifiedly for commercial plantations; but if it should maintain in other localities the high mark of excellence attained at this Station, the variety will soon stand at the front among black raspberries. It is especially remarkable for its hardiness. During the past two years there has been almost no winter injury with the thermometer twice at 14 degrees below zero. The bushes are all that could be desired in vigor and productiveness while the foliage, though small, is healthy, as indicated by its luxuriant, dark green color. Up to the present, the canes have been but slightly attacked by anthracnose. The berries are large although somewhat variable in size, a deep, glossy black, ship well, are pleasantly sprightly and rank good in quality. The season is early, the berries maturing a week or more before Gregg. All indications are that the variety has come to stay as a commercial sort. Certainly it is worth growing in a home collection.



MARLDON

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Black Pearl is a chance seedling found in a planting of Kansas in 1905 by Herman Krumrei, St. Joseph, Missouri, and was introduced by Holsinger Bros., Rosedale, Kansas, in 1907. In the west it is said to be more resistant to drought than other varieties.

Plants vigorous, upright, very productive, hardy; canes stocky, numerous, dull brownish-red, often with heavy bloom; spines slender. Leaves small, dark green, rugose, heavily pubescent beneath. Flowers bloom early, in short, compact clusters; petals small, oval, tapering to rather long, narrow claws. Fruit matures early; large, regular in shape, with drupes of medium size, not inclined to crumble, attractive black, with slight pubescence, juicy, somewhat seedy; flavor sprightly; good in quality.

Marldon, a most promising new red raspberry, was described in Bulletin No. 298 as a Station seedling of merit. Plants were distributed during the spring of 1908. Since that time the variety has continued to make good on the grounds of this Station and reports received from growers in other parts of the State indicate that it may fill most acceptably a place for commercial purposes in the season between June and Cuthbert. The bushes of Marldon are of Marlboro type though more vigorous and stockier. Plants develop rapidly from numerous suckers and on this account care should be taken as to distance of planting and in pruning or the plants will soon become crowded and the size and quantity of the fruit thereby be diminished. The berries are large, retain their size well as the season advances and most of the fruit matures during a short period — one of the reasons why it fits so well between June and Cuthbert. The color is a handsome dark red and, while the berries are not as sweet nor as high-flavored as the best standard varieties, the quality ranks above the average. Because of the hardiness, vigor, and productiveness of the bushes and the large size and handsome color of the fruit, Marldon is worthy of a trial as a commercial sort in all parts of New York.

Marldon is one of the four promising seedlings retained out of 1191 plants the breeding of which was begun by this Station in 1897. The parents of Marldon were Marlboro X Loudon. As already stated, the variety was disseminated in the spring of 1908 among about 200 commercial growers of raspberries. Very promising reports have been received from many of these growers and in some localities it is already rated as a valuable variety for commercial purposes. Plants of this variety are no longer available from this Station. A number of nurserymen are growing the Marldon and stock should soon be available from them or from the growers who first received stock from this Station.

Plants vigorous, upright, hardy, productive, healthy; canes more vigorous and stockier than either Marlboro or Loudon, light brownish-gray; prickles slender, weak, few in number. Leaves oblong-oval, thick, dark green, rugose. Flowers large; petals small, oval, tapering to short, broad claws. Fruit matures in mid-season, about one week earlier than Cuthbert; large, uniform in size, with rather large, numerous, coherent drupes, handsome dark red, juicy, firm, pleasantly sprightly; fair to good.

STRAWBERRY.

Amanda has been under observation at this Station for several years, having first fruited in 1908. Every year the fruit has attracted attention because of its desirable qualities. We now have no hesitation in recommending Amanda for trial, both for home use and for commercial purposes. Sufficient room must be given both for rows and plants as the runners are produced in great numbers. The plants, although vigorous and ranking among the most productive of over one hundred varieties, are somewhat susceptible to leaf spot under unfavorable conditions. The blossoms are perfect and open in mid-season or later, usually after danger from late spring frost is past. The great asset of Amanda is the fruit. The berries ripen in mid-season, are large and hold up remarkably well throughout the ripening season. The color varies from light to dark scarlet depending on the stage of maturity and is always glossy and attractive. In shape, the berries are usually a distinct blunt-wedge although roundish-conic forms may be found among them. The flesh is firm enough to stand the wear and tear of distant shipments and its color is good to the very center. There is enough acidity of flavor to give sprightliness which, combined with other characters, makes the variety rank high in quality. Amanda is well worthy of trial for home but more particularly so for market.

This variety was originated by Z. T. Mumma of Blufftown, Ohio, in 1904, by crossing Sample with pollen from Maximus. It was introduced by Mr. J. Whitt, Vermillion, Ohio, in 1910, and is already catalogued by a number of nurserymen.

Plants very numerous, vigorous, somewhat susceptible to leaf spot, very productive; leaves of average size and color; leaf-stalks long, medium to slender; flowers perfect, blooming in mid-season or later. Fruit-stems long, thick, branched, erect; calyx of medium size, sometimes somewhat discolored, sunken or flattened; fruit matures in mid-season; large, retains its size well to the close of the ripening period, wedge-shaped to roundish-conic, glossy, light to dark scarlet; seeds strongly depressed; flesh well colored to the center, very firm, pleasantly acid, agreeably flavored; good in quality.

SECOND DISTRIBUTION OF STATION APPLES.*

U. P. HEDRICK.

The New York Agricultural Experiment Station distributed twelve varieties of apples in 1914. We have for the season of 1915 six additional sorts that we are desirous of having tested in various parts of the State. These varieties, as were the twelve sent out last year, are the outcome of experimental work in plant breeding. They have been grown and compared with practically all of the standard sorts of their kind and are equal or superior in one or more respects to apples of their season, as grown on the Station grounds. The distribution of these varieties is undertaken that we may ascertain their value and adaptability in the different fruit regions of New York. A fuller description of most of the varieties listed has been published in Bulletin No. 350 from this Station.

TERMS OF DISTRIBUTION.

There are no restrictions upon recipients of plants as to further distribution of the varieties by sale or otherwise. If the fruits prove meritorious, it is desired that they be generally disseminated as quickly as possible. We only ask that those who receive the plants report to the Station, in regard to the behavior of the varieties, on blanks which will be furnished when the plants come in bearing.

The trees are sent without charge but the recipient must pay expressage. Applicant must give both mail and express addresses.

The Station reserves the right to make a choice of growers to whom the trees will be sent. This choice will depend chiefly upon priority of application and upon the number of applicants from a locality.

Only one tree of a variety can be sent to an applicant, but it is desired that a person receiving any should receive all of the varieties, that a comparative test may be made of them.

The trees have been fumigated and the tops have been dipped in an insecticide, but the Station does not guarantee them to be free from San José scale.

Address all correspondence regarding these new fruits to the Horticultural Department, New York Agricultural Experiment Station, Geneva, N. Y.

STATION APPLES.

Chautauqua (Esopus X Ben Davis).—Tree vigorous, upright-spreading, dense-topped, productive. Season, January to May; medium to above in size, roundish-

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* A reprint of Circular No. 37, February 15, 1915.

conic to roundish-oblate, somewhat ribbed, often oblique and with unequal sides; color greenish-yellow, overspread with a mottled, dark dull red, heavily splashed with carmine, prevailing effect red; flesh greenish-yellow, firm, coarse, crisp, juicy, subacid; good in quality. The fruit of this cross is the type of Esopus, often with a deeper color, with flesh-characters at first somewhat like the male parent but improving as the season advances. The shallow and often greenish cavity with its long, slender stem resembles Rome. Worthy of test on account of size of fruit and lateness of season, although in some seasons the color is somewhat dull and the flesh affected with Baldwin spot.

Cortland (Ben Davis X McIntosh).—Tree of medium vigor, drooping, dense-topped, productive. Season, November to February; above medium in size, roundish-oblate, ribbed, uniform; color greenish-yellow overspread with bright red, darker on the sunny side, splashed and striped with carmine; flesh whitish, often with slight tinge of pink, fine-grained, crisp, tender, juicy, subacid, aromatic; of good quality. In appearance Cortland closely resembles McIntosh in color, shape and flesh characters. It promises to be a valuable commercial apple of the McIntosh type.

Onondaga (Ben Davis X McIntosh).—Tree not very vigorous, upright, dense-topped, productive. Season, November to January; above medium in size, roundish-conic, irregular; color greenish-yellow, almost entirely overspread with dark McIntosh red, darker on the sunny side, splashed and mottled with dark carmine, prevailing effect dark red; flesh tinged with yellow, firm, crisp, tender, juicy, sprightly subacid, aromatic; of good quality. This apple is very attractive in color and in size and is at least desirable for cooking and would doubtless be relished by most persons as a dessert fruit. It is the general type of McIntosh externally except that it is slightly more conic.

Oswego (Sutton X Northern Spy).—Tree vigorous, upright-spreading, dense-topped, productive. Season, December to April; large, roundish-conic, ribbed, sides unequal; color greenish-yellow overspread with dull pinkish red, splashed and striped with darker red, prevailing effect dull red; flesh yellowish, firm, crisp, tender, juicy, brisk subacid; very good in quality. Oswego resembles Northern Spy, though larger, more conical, and brighter in color. The flesh, in color and texture, resembles Spy but the flavor, while equal to that variety, is not that of the Spy.

Schenectady (Ben Davis X Mother).— Tree vigorous, upright, dense-topped, productive. Season, November to January; large, roundish-conic, sides unequal, ribbed; color greenish-yellow overspread with bright red, mottled and splashed with carmine, prevailing effect red; flesh yellowish, firm, coarse, crisp, tender, juicy, subacid; of good quality. This new variety is remarkably attractive, its size, shape and color, all being most pleasing. It is not quite high enough in quality to be called a first-class dessert fruit, but it is much better than Ben Davis and is a splendid apple.

Tioga (Sutton X Northern Spy).—Tree very vigorous, upright-spreading, dense, medium productive. Season, December to March; large, oblate-conic, ribbed, symmetrical; color pale yellow, blushed, mottled and faintly splashed with pinkish-red, prevailing effect yellowish; flesh yellowish, firm, coarse, crisp, juicy, brisk subacid; of good quality. A most promising variety because of its handsome appearance and high quality. The fruit is of Northern Spy type in shape but is unlike either parent in color.

STRAWBERRY VARIETIES.*

O. M. TAYLOR.

INTRODUCTION.

This bulletin is a report on varieties of strawberries tested at this Station during the past three years. The kinds grown include newer varieties, with standard commercial kinds for purposes of comparison. Both plant- and fruit-habits will vary in other localities under different climatic and soil conditions and it cannot be expected that the varieties which have made such a favorable record here will all do equally well elsewhere, and doubtless some which are reported as failures will develop better in other places. It is not necessary at this time to discuss in detail selection of varieties or cultural treatment. These subjects are included in a circular of this Station.[1] All varieties received the same general treatment during the three years, the matted-row system being followed. Due allowance should be made for fall-bearing kinds which were treated in all respects as the other varieties and were not tested with reference to their fall-bearing value. The soil at this Station is a rather cold, heavy, clay loam, not naturally well adapted to the strawberry.

Temperature and rainfall.— Climatic conditions are controlling factors in plant and fruit development. Variations in character of growth are at times directly attributable to variations in temperature and rainfall. For this reason it is important to know the conditions under which strawberry varieties have been grown. Differences in moisture conditions are exceedingly variable in different localities during the same season or even in the same locality during different months of the same year or during the same month of different years. As this bulletin deals with the behavior of varieties on the grounds of this Station the following table is given to show the local conditions of heat and moisture during the most important months of growth of the strawberry.

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[1] Circular No. 31, Strawberries.

* A reprint of Bulletin No. 401, March, 1915.

AVERAGE TEMPERATURE AND TOTAL RAINFALL DURING GROWING SEASON.
(Experiment Station, Geneva, N. Y.)

Year	April		May		June		July		August		Sept.		Oct.	
	Av. temp.	Tot. rainfall	Av. temp.	Tot. rainfall	Av. temp.	Tot. rainfall	Av. temp.	Tot. rainfall	Av. temp.	Tot. rainfall	Av. temp.	Tot. rainfall	Av. temp.	Tot. rainfall
		Ins.		*Ins.*		*Ins.*		*Ins.*		*Ins.*		*Ins.*		*Ins.*
1910....	50.1	4.56	54.9	3.45	65.2	1.55	73.1	2.39	69.	5.47	63.2	3.29	53.1	1.73
1911....	44.8	3.24	64.9	1.36	67.5	2.51	74.4	4.49	70.9	3.36	62.8	3.21	50.7	2.37
1912..	45.1	3.41	58.9	7.27	64.3	2.09	73.2	4.85	68.6	2.21	68.4	5.89	53.5	1.42
1913....	48.3	3.40	56.9	2.68	66.8	3.24	72.1	2.03	70.	1.65	61.3	2.64	54.	4.08
1914....	43.4	3.10	60.2	4.	67.3	2.69	71.6	2.18	70.5	6.05	61.4	1.62	55.4	1.55

So far as moisture is concerned the most critical time in the life of the strawberry is as the fruit begins to mature and during the ripening period. This, at Geneva, is during the months of June and July. As shown by the table the variation in rainfall during the past five years has been from 1.55 inches to 3.24 inches for June and from 2.03 inches to 4.85 inches for July. The bulk of the strawberry crop, however, matures at Geneva between June 15 and July 15. The following figures taken from the meteorological record show clearly the wide ranges in number of showers between those dates: 1910 — 6 showers; 1911 — 4 showers; 1912 — 6 showers; 1913 — 8 showers; 1914 — 13 showers. Yield is affected also by the amount of rainfall in August and September at which time runners are developing most rapidly. In a dry season but few plants root. In August, 1913, the total rainfall was 1.65 inches and in 1914, 6.05 inches for the same month.

NOTES ON VARIETIES.

Blooming season.— The time of bloom is of special importance in those localities subject to late spring frosts. Opening of the blossoms may be retarded somewhat by the winter mulch. A few days delay in blooming season may mean an increase of from one-third to one-half in yield provided the opening blossoms get safely past the critical frost periods. The following lists include the early- and late-blooming varieties, the other varieties described in this bulletin opening their blossoms in mid-season.

EARLY BLOOMERS.

Abington
Baltimore
Barkley
Black Beauty
Catlin No. 1
Consort
Corinne
Dunmore
Early Jersey Giant
Early Queen
Ettersburg No. 88
First Prize
Four Seasons
Goodell
Lea
Maryland Prize
Missionary
Monroe
Nanticoke
Progressive
Red Prolific
St. Joseph
Schild No. 2
Schild No. 8
Schild No. 10
Schild No. 12
Sons Prolific
Sweetheart
Superb
Uncle Sam
Winner

LATE BLOOMERS.

Barrymore
Bethel
Buster
Chesapeake
Columbia
Ettersburg No. 71
Ettersburg No. 80
Ettersburg No. 84
Ettersburg No. 89
Ettersburg No. 91
Ettersburg No. 93
Ettersburg No. 94
Ettersburg No. 111
Ettersburg No. 112
Ettersburg No. 114
Ettersburg No. 121
Fillbasket
Good Luck
Indiana
Latest of All
Mascot
Maud Muller
Ohio Boy
Phoenix
Posey
Repeater
Schauber No. 705
Walnut Stump

Season of ripening.— The particular market to be supplied is the controlling factor in selection of varieties with reference to their time of maturity. Some markets demand an early or mid-season berry while in other localities the latest-maturing varieties are most profitable. The greatest number of varieties are usually to be found among the mid-season kinds, and the varieties described in this bulletin are no exception to the rule. Less than one-third of the total number of varieties described in this bulletin are in either the early or late class.

VARIETIES THAT MATURE EARLY.

Atkins Continuity
Barkley
Black Beauty
Dunlap
Early Jersey Giant
First Prize
Golden Gate
Grand Marie
Hughson
Indiana
Ionia Market
Lea
Maud Muller
Missionary
Monroe
Nanticoke
Progressive
Red Prolific
Repeater
Rose Ettersburg
Saint Joseph
Schild No. 2
Schild No. 8
Schild No. 10
Schild No. 12
Sons Prolific
Superb
Uncle Sam
Winner

VARIETIES THAT MATURE LATE.

Columbia
Dewdrop
Diehl No. 1
Ettersburg No. 71
Ettersburg No. 75
Ettersburg No. 76
Ettersburg No. 79
Ettersburg No. 80
Ettersburg No. 84
Ettersburg No. 89
Ettersburg No. 91
Ettersburg No. 93
Ettersburg No. 94
Ettersburg No. 111
Ettersburg No. 112
Ettersburg No. 114
Ettersburg No. 121
Fillbasket
Late Jersey Giant
Latest of All
Laxton Latest
Mascot
Patagonia
Rough Rider
Schauber No. 705
Walnut Stump

Sex of flowers.— By far the greatest number of varieties grown are perfect-flowering. This is due in part to the desirable qualities of such varieties but in larger measure, to the fact that the imperfect-flowering or pistillate kinds will not produce satisfactory crops of fruit when planted alone but must have perfect-flowering varieties growing nearby to insure pollination of the blossoms. The perfect-flowering kinds are not necessarily better yielders or of higher quality. The sex of the varieties tested is indicated in the description of the variety; 77 are perfect-flowering and 29 imperfect-flowering.

Plant-makers.— Most varieties set too many plants. The results would be more satisfactory with half the number properly spaced. Crowded conditions are brought about partly by close planting and partly by the rapidity with which runners develop. In other cases the variety may be a shy plant-maker and unless the usual planting distance is decreased a diminished yield results. This is especially true with Chesapeake — one of the best of varieties. All gradations in number of plant-makers are found in the varieties under discussion. The extremes are as follows:

PROLIFIC PLANT PRODUCERS.

Amanda
Buster
Columbia
Corinne
Dunlap
Early Queen
Ettersburg No. 80
Ettersburg No. 84
Ettersburg No. 89
Ettersburg No. 91
Helen Davis
Killarney
Maud Muller
Missionary
Posey
Prolific
Schild No. 10

SCANTY PLANT PRODUCERS.

Autumn
Chesapeake
Danby
Dewdrop
Diehl No. 1
Four Seasons
Goodell
Goodwin
Gov. Fort
Hub
Laxton Latest
Lea
Productive
Schild No. 12
Sons Prolific
Superb
Uncle Sam

Productiveness.— Many factors influence yield of fruit, the most important being moisture, food supply and adaptation of the variety. During the three-year test the widest variations in rainfall have occurred as shown by the table on page 166. Each year, in preparation of the soil, liberal and uniform applications of stable manure were made. Yet during the same year with all conditions as uniform as could be secured the yield has ranged from a decidedly small crop to very heavy yields, apparently due largely to the degree of adaptability of the variety to soil and climatic conditions. Relative productiveness was determined by repeated observations made during the fruiting period of the different varieties. The following varieties include only those at the extremes of yield.

Very Productive Varieties.

Abington
Amanda
Autumn
Barrymore
Bethel
Buster
Catlin No. 1
Columbia
Dunlap
Early Jersey Giant
Early Queen
Ettersburg No. 71
First Prize
Golden Gate
Goodell
Good Luck
Late Jersey Giant
Maryland Prize
New Discovery
Ohio Boy
Schauber No. 701
Sweetheart
Superb
Winner

Very Unproductive Varieties.

Atkins Continuity
Ettersburg No. 112
Four Seasons
Laxton Latest
Peach

Vigor of plant.— Habit of growth is closely associated with amount of nitrogenous plant food in the soil; yet certain varieties always retain to a marked degree growth-characters which are not overcome by heavy applications of stable manure or nitrate of soda. The following varieties are characterized by a low-growing habit or the plants are small, or weak.

Low-growing or Weak Varieties.

Ettersburg No. 79
Ettersburg No. 112
Four Seasons
Goodell
Hub
Latest of All
Red Prolific
Repeater
Saint Joseph
Schauber No. 701
Sons Prolific

Resistance to disease.— Fortunately there are but few diseases affecting the strawberry, chief of which is leaf spot. This disease, however, is largely dependent on favorable weather conditions for its development and spread. The same variety may suffer severely one season, yet be comparatively free from the trouble the following year. We may, however, find a healthy variety growing alongside one severely injured by the disease showing that considerable variation exists in the ability of a variety to withstand attacks of the fungi. The following varieties were severely attacked by leaf spot during the past three years.

Varieties Susceptible to Leaf Spot.

Atkins Continuity
Big Rock
Commission
Diehl No. 1
Ettersburg No. 80
Ettersburg No. 89
Ettersburg No. 91
Ettersburg No. 93
Ettersburg No. 111
Ettersburg No. 114
Ettersburg No. 116
Ettersburg No. 121
Fillbasket
Goodwin
Helen Davis
Killarney
Laxton Latest
Patagonia
Peach
Peckham Wonder
Posey
Schild No. 8
Schild No. 10

Size of fruit.— Size of fruit is an essential factor. Many varieties attractive in color and of highest quality are deficient in size, the berries averaging so small as to make the variety worthless commercially and undesirable for home use. Some varieties naturally produce nothing but small berries, others a uniform crop of large fruit while still other kinds have no uniformity in size, large and small berries being harvested at each picking. As the fruit was taken from the vines, notes were made as to the size of fruit. The following varieties produced fruit at the two extremes.

Varieties Producing Fruit of Largest Size.

Barrymore
Buster
Chesapeake
Danby
Dewdrop
Early Jersey Giant
First Prize
Golden Gate
Good Luck
Grand Marie
Granger
Indiana
Killarney
Late Jersey Giant
Marshall
Maryland Prize
Mascot
New Discovery
Posey
Prolific
Schild No. 10
Townsend Late Champion

Varieties Producing Fruit of Smallest Size.

Atkins Continuity
Autumn
Catlin No. 1
Ettersburg No. 75
Ettersburg No. 79
Ettersburg No. 116
Ettersburg No. 121
Four Seasons
Goodell
Latest of All
Lea
Saint Joseph
Uncle Sam

Quality.— It is always difficult to determine accurately the quality of varieties. All gradations may be found from the poorest to the best. Much depends on the stage of ripeness of the particular berries sampled, on the amount of sunshine and rainfall under which the berries ripened, and on the personal taste of the person making the test. Some varieties not of highest quality are among the best commercial sorts because of large yield, good size, attractiveness of color and desirable shipping qualities. The rating of each variety as to quality is given in its description. The following is a list of those varieties having a high rating of quality.

Varieties Rating High in Quality.

Barrymore
Black Beauty
Chesapeake
Clara
Columbia
Ettersburg No. 112
Goodell
Good Luck
Goodwin
Granger
Kittie Rice
Marshall
Maryland Prize
Mascot
New Discovery
Peach
Phoenix
Saint Joseph
Schauber No. 701

Desirable kinds.— Nearly all varieties may be characterized by their faults. These faults are more prominent some years than in others. Habits vary in different localities. A most desirable variety in one place may be worthless elsewhere. It is, therefore, impossible to make out a list of desirable kinds that will be satisfactory for all locations. The following list is only suggestive. It includes those described in this bulletin which have made the best record during the past three years under the soil and climatic conditions at this Station. The list includes some varieties described in previous bulletins which had made a good record and which were again grown for purposes of further observation and for comparison with varieties of more recent origin. They will not all do equally well elsewhere. The only sure way of determining their value is by a trial of a few plants on each grower's soil before planting extensively for commercial purposes.

Desirable Varieties.

Abington (Per)
Amanda (Per)
Baltimore (Per)
Barrymore (Per)
Black Beauty (Imp)
Chesapeake (Per)
Clara (Per)
Columbia (Imp)
Dunlap (Per)
Ettersburg No. 80 (Per)
Ettersburg No. 84 (Per)
Ettersburg No. 89 (Per)
Ettersburg No. 112 (Per)
Golden Gate (Per)
Good Luck (Per)
Goodwin (Per)
Grand Marie (Per)
Granger (Imp)
Indiana (Per)
Kittie Rice (Imp)
Marshall (Per)
Mascot (Per)
Monroe (Per)
New Discovery (Per)
Phoenix (Per)
Posey (Per)
Prolific (Per)
Rough Rider (Per)
Schild No. 10 (Per)
Sherman (Imp)

DESCRIPTION OF VARIETIES.

It must be kept in mind that the descriptions of plant and fruit as given in the following pages represent the behavior of the variety on heavy clay soil at this Station. They may vary in other localities. Plants of the varieties described cannot be obtained at this Station. The name of the party furnishing plants for trial is given following the name of the variety. Whenever possible stock has been obtained directly from the originator or introducer. The first paragraph gives history of the variety, the second paragraph description of both plant and fruit and the third paragraph summary of the variety.

IMPORTANT! Descriptions partial only.— Certain plant-habits of a large number of varieties are intermediate in their character, as — plants medium in vigor, number or yield; leaves medium green in color; petals not few or many; calyx medium in size. In such cases, especially where the characteristics are not essential distinguishing factors, the description is omitted, it being understood in all such cases that the omission of description is an indication that a certain character is intermediate in degree.

Abington.— (W. F. Allen, Salisbury, Md.) Fully described and recommended for trial in Bulletin No. 309, 1908. Although not of highest quality worthy of trial for a light-red berry on account of productiveness, size and general attractiveness.

Amanda.— (J. Whitt, Vermillion, O.) Described and recommended for trial in Bulletin No. 309, 1908. Introduced by Mr. Whitt in 1910. Worthy of test as a large, rather dark red, wedge-shaped berry of good quality.

Atkins Continuity.— (Wm. Fell, Hexham, England.)

Plants unproductive, with considerable leaf spot; leaves dark green; flowers perfect, bloom in mid-season, nearly one inch across; petals ovate; stamens numerous, long; fruit-stems short, semi-erect; calyx rather large, very pubescent, slightly depressed; seeds prominent. Fruit matures early; above medium in size, roundish-conic to wedge, medium red, glossy; apex obtuse; flesh whitish towards center, firm, mild subacid, not high flavor; fair in quality.

Plants subject to disease and lacking in productiveness. Fruit inferior to the best commercial kinds in size, flavor and quality.

Autumn.— (Samuel Cooper, Delevan, N. Y.) A seedling of Pan American originated in 1902 by Mr. Cooper and introduced by him in 1906.

Plants very few, very productive considering the number of plants, slightly affected by leaf spot; leaves dark green; flowers imperfect, small, averaging but slightly more than three-quarter inch across; petals overlapping, roundish-oblate, five to six in number; calyx flat; seeds prominent. Fruit medium in size, conic but broad and flattened at the base, attractive medium red; apex somewhat pointed; flesh well colored to center, juicy, firm, sweet, pleasant flavored; good in quality.

Plants very few in number requiring close planting, very productive per plant. Fruit inferior in size, pleasant flavored, high in quality.

Baltimore.— (E. W. Townsend, Salisbury, Md.) Supposed to have originated in Germany about 1884. Mr. Townsend secured plants in 1909 and introduced the variety in 1912.

Plants numerous, vigorous, productive, slightly affected with leaf spot; leaves small, dull, light green, rugose; flowers perfect, blooming season early, over one inch across; petals small, roundish; stamens numerous, long; receptacle small; fruit-stems short, thick, erect, branching; calyx large, flat; seeds small, usually sunken. Fruit matures in mid-season; large, irregular in shape varying from wedge to often coxcomb, glossy, medium red; apex variable, conic to wedge; flesh whitish towards center, juicy, rather tender, sweet, mild, strongly aromatic; good in quality.

The habit of plants is desirable although somewhat subject to disease; a mid-season berry of attractive appearance, good size and quality but somewhat variable in shape; an excellent shipper; worthy of test.

Barkley.— (E. W. Townsend, Salisbury, Md.) A seedling of unknown parentage found growing wild in 1905 by Mr. S. Barkley of Wicomico County, Md., and introduced by Mr. Townsend in 1913.

Plants numerous, large, vigorous, productive, slightly affected with leaf spot; leaves large, medium to dark green, slightly rugose; flowers perfect, season of bloom early, one and one-eighth inches across; petals roundish; stamens numerous; receptacle medium to small; fruit-stems thick, erect; calyx variable in size, unattractive green; seeds sunken. Fruit matures early; large to medium, conic to wedge, light to medium red, dull, unattractive, colors unevenly; apex pointed; flesh somewhat whitish towards center, firm, sweet, mild, pleasant flavor; good in quality.

Plants multiply rapidly and yield well. Fruit high in quality but is too dull in color and variable in size.

Barrymore.— (W. F. Allen, Salisbury, Md.) Fully described in Bulletin No. 385, 1914.

Worthy of test on account of heavy yield, large size of fruit, desirable shape, unusually attractive color and flavor and quality closely rivaling Marshall; an excellent shipper; must be well colored before picking.

Berlin.— (H. J. Schild, Ionia, Mich.) A seedling of Haverland originated by Mr. Schild in 1902 and introduced by him in 1907.

Plants numerous, vigorous, productive, healthy; leaves rather smooth; flowers imperfect, bloom in early mid-season, less than one inch across; petals small, broad-oval; receptacle small, conical; fruit-stems long, slender, semi-erect, but little branching, producing fruit densely clustered; calyx small, flat; seeds raised. Fruit matures in mid-season; above medium in size, long-conic to wedge, light red, glossy, colors unevenly; apex pointed; flesh whitish towards center, very juicy, tart, not pleasant in flavor; poor in quality.

Plant-characters good; chief defects are in the fruit; a long-pointed, unattractive, light red berry inferior in flavor and too soft for long shipments.

Bethel.— (W. S. Todd, Greenwood, Del.) A seedling of unknown parentage originating in 1906 with R. F. Thomas, Kent County, Del., and introduced by Mr. Todd in 1910.

Plants very productive, healthy; leaves small, dark green; flowers perfect, season of bloom late, three-quarters inch across; petals roundish-oval; stamens short; fruit-stems long, thick; calyx raised; seeds sunken. Fruit matures in mid-season; above medium in size, irregular in shape, often wedge or coxcomb, with roughish and furrowed surface, medium red; apex obtuse, often seedy in appearance; flesh well colored to center, juicy, firm, rather tart; fair in quality.

A very productive variety, unattractive in shape, often seedy, lacks sweetness, inferior in flavor and quality.

Big Rock.— (H. J. Schild, Ionia, Mich.) Originated by Mr. Schild in 1905 as a cross between Red Dawn and Red Queen, and introduced by him in 1910.

Plants numerous, productive, somewhat subject to attacks of leaf spot; leaves large, very thick; flowers perfect, bloom in late mid-season, one and one-quarter inches across; petals large, roundish; stamens numerous; receptacle large, roundish; fruit-stems short, thick, prostrate, branching; calyx large, varying from raised to depressed; seeds sunken. Fruit matures in mid-season; large, furrowed, irregular wedge, often necked, variable color averaging medium red, somewhat glossy; apex obtuse, indented; flesh whitish towards center, not very juicy, firm, sweet, mild; fair to good in quality.

Foliage large, characteristically thick, not healthy; fruit of good size but variable in shape, not very attractive in color, lacking in juiciness and surpassed in quality by other varieties.

Black Beauty.— (W. S. Todd, Greenwood, Del.) Originated by H. J. Schild, Ionia, Mich., in 1905 as a cross between Red Dawn and one of his seedlings, No. 19, the parentage of which is Red Dawn X Ionia Market. Introduced by A. B. Sibert, Rochester, Indiana, in 1910.

Plants productive, healthy; leaves dark green; flowers imperfect, coming in bloom early, less than an inch across; petals small, overlapping, ovate; fruit-stems short, thick; calyx small, raised; seeds raised. Fruit matures early; medium to large, wedge-shaped, necked, attractive dark red; apex obtuse, somewhat seedy; flesh well colored to center, very juicy, firm, tart, sprightly, high flavored; very good in quality.

An imperfect-flowering variety of good plant-habits, worthy of test on account of the high quality of the dark, glossy-red berries; apex inclined to be seedy in appearance, and on this account the fruit should be well colored before its removal from the plants.

Bull Moose.— (T. C. Kevitt, Athenia, N. J.) Originated in 1901 as a cross between Sample and Glen Mary, by Mr. Kevitt and introduced by him in 1912.

Plants large, vigorous, healthy; leaves large, dark green, rugose; flowers imperfect, bloom thirteen-sixteenth inch across; petals roundish, five to seven in number; receptacle large, prominent; fruit-stems long, thick, semi-erect, usually double; calyx flat; seeds sunken. Fruit matures in mid-season; large to medium, blunt-conic, dull, light to medium red; apex obtuse, not always well developed; flesh whitish toward center, juicy, very firm, sweet, good.

The defects of this variety are in the fruit rather than in the plants. Although an excellent shipper and of good quality, the berries are variable in size, rather unattractive in color and the apex is often poorly developed. Surpassed in value by other varieties.

Buster.— (R. M. Kellogg Co., Three Rivers, Mich.) A cross of Sharpless and Bubach made about 1908, by a Mr. Stone of Illinois.

Plants very numerous, vigorous, very productive, healthy; leaves dark green, slightly rugose; flowers imperfect, season of bloom late, small, thirteen-sixteenth inch across; petals roundish; fruit-stems thick, semi-erect, branching; calyx small, strongly depressed, dull green; seeds inconspicuous, sunken. Fruit matures in mid-season; large, furrowed, inclined to roundish, light red, dull and rather unattractive, colors unevenly; apex obtuse; flesh whitish toward center, juicy, bruises easily, subacid, lacking in flavor; fair in quality.

The number, vigor and productiveness of plants are strong characteristics, as is also the sunken calyx. The fruit, however, although of large size which holds up well throughout the season, does not ship well, is unattractive in color and inferior both in flavor and quality.

Catlin No. 1.—(H. A. Catlin, Homer, N. Y.) A seedling of unknown parentage from seed of berries found in a meadow and grown by Mr. Catlin in 1910; sent to this Station for testing in 1913.

Plants numerous, large, vigorous, very productive, with only a trace of leaf spot; leaves large, dark green, rugose; flowers perfect, season of bloom early, seven-eighths inch across; petals roundish, five in number; stamens numerous; receptacle medium to small; fruit-stems long, erect; calyx small, slightly raised; seeds sunken. Fruit matures in mid-season; medium to small, oval to conic, slightly necked, dull, unattractive dark red; apex pointed; flesh whitish toward center, firm, sweet, pleasant flavor; good in quality.

Plant-characters desirable but fruit too small for commercial value although of good flavor and quality.

Chesapeake.— (W. F. Allen, Salisbury, Md.) Described and recommended for trial in bulletins No. 309, 1908, and No. 364, 1913, of this Station on New or Noteworthy Fruits. Fruited again in 1914, the variety still making an excellent showing.

Clara.— (J. E. Kuhns, Cliffwood, N. J.) A seedling of Sample crossed with Wm. Belt, originating in 1903 with Mr. Kuhns and introduced by him in 1909.

Plants numerous, healthy; leaves small, light green, slightly rugose; flowers perfect, one inch across; petals small, roundish; stamens short to medium in length; receptacle large, prominent; fruit-stems short to medium, thick, prostrate, branching; calyx large, often slightly raised, pale green; seeds small, conspicuous, variable in position. Fruit matures in mid-season; large, slightly furrowed, wedge to irregular conic, glossy, attractive dark red; apex often wedge-shaped; flesh well colored to center, juicy, firm, pleasant flavored, sprightly; good to very good.

Plant-characters desirable although not quite as productive as some other varieties. Fruit attractive both in size and color, somewhat irregular in shape, ranks high in quality. In the last pickings the smaller berries are rather seedy in appearance. An excellent shipper. Worthy of test on account of its many desirable characters.

Columbia.— (J. B. Wild & Bros., Sarcoxie, Mo.) Described as a promising variety in Bulletin No. 309. Crescent was crossed with Sharpless and one of the most promising seedlings of this cross was fertilized with pollen from Parry. One of the most promising of these seedlings, No. 9, was named Columbia by a Mr. Richard Bagg.

Commission.— (H. J. Schild, Ionia, Mich.) Originated by Mr. Schild in 1905 by crossing Red Dawn with one of his seedlings, No. 19, parentage of which was Red Dawn X Ionia Market. Introduced by Mr. Schild in 1909.

Plants numerous, vigorous, above medium in height, productive, somewhat subject to attacks of leaf spot; leaves large, dark green, slightly rugose; flowers perfect, bloom in early mid-season, one and seven-sixteenths inches across; petals large, roundish-oval; stamens numerous, long; receptacle roundish; fruit-stems variable in length, thick, semi-erect, much branching; calyx large, raised, leafy, often discolored; seeds sunken. Fruit matures in mid-season; medium in size, irregular in shape averaging blunt-wedge, strongly necked, dull, unattractive light red; apex obtuse, indented; flesh whitish toward center, very juicy, sweet, mild, not high flavored; fair in quality.

Plant-characters good except for attacks of leaf spot; a medium-sized berry with distinct neck, inferior in shape, unattractive in color, low in flavor.

Consort.— (A. B. Sibert, Rochester, Ind.)

Plants numerous, vigorous, above medium in height, productive, healthy; leaves large, rather rugose; flowers imperfect, season of bloom early, nearly one inch across; petals small; receptacle prominent, blunt-conic; fruit-stems medium to long, thick, prostrate, branching; calyx large, flat or raised, leafy, dull green; seeds sunken. Fruit matures in mid-season; large, furrowed, wedge-shape, slightly necked, dull, very dark unattractive red; apex pointed or wedge; flesh very dark red to center, firm, sweet, mild; good in quality.

Plants make a good growth. Fruit large at first, decreasing rapidly in size as season advances; a dark red berry with very dark red flesh, with roughish surface, unattractive appearance; not recommended.

Corinne.— (A. B. Sibert, Rochester, Ind.)

Plants very numerous and vigorous, productive, healthy; leaves large, dark green, smooth; flowers imperfect, season of bloom early, small, averaging three-quarters inch across; petals very small, roundish-oval, seven to ten in number; receptacle roundish; fruit-stems thick, prostrate, branching; calyx small, flat; seeds large, sunken. Fruit matures in mid-season; above medium to medium in size, roundish-conic, broad at the base, glossy, medium to dark attractive red; apex very obtuse; flesh well colored to center, tender, sweet, mild, pleasant flavored; good in quality.

Plants characteristically large, vigorous, multiply rapidly and with characteristic dark green foliage; blossoms hidden in the dense foliage. Fruit well-shaped, excellent color, desirable quality but deficient in size and bruises easily; surpassed by other varieties.

Danby.— (H. J. Schild, Ionia, Mich.) Originated by Mr. Schild in 1903 by crossing two of his seedlings, No. 18 and No. 907; introduced by him in 1910.

Plants few, vigorous, above medium in height, productive, healthy; leaves large, dark green, glossy; flowers imperfect, bloom one and one-sixteenth inches across; petals roundish, six to nine in number; receptacle long-conic; fruit-stems short, thick, prostrate, branching; calyx large, slightly raised, leafy; seeds variable in position. Fruit matures in mid-season; very large, furrowed, wedge-shape, sometimes slightly necked, glossy, attractive medium red, colors somewhat unevenly; apex obtuse; flesh well colored to center, juicy, firm, sprightly; good in quality.

Fruited in 1912 and again in 1913. A poor plant-maker and must be set closely to secure a good yield. Fruit of desirable size, variable in color, too soft for a good shipper, of doubtful value although pleasant flavored and of good quality.

Darlington.— (W. F. Allen, Salisbury, Md.)

Plants healthy; leaves small, light green, rugose; flowers perfect, one and one-sixteenth inches across; petals roundish, average eight in number; stamens decidedly variable in number, very short; receptacle large, prominent, roundish; fruit-stems short, thick, prostrate, usually single; calyx large, depressed, somewhat leafy; seeds small, sunken. Fruit matures in mid-season; large, often furrowed, roundish-conic to a very blunt and wide wedge, dull, unattractive medium red, colors unevenly; apex indented, often green-tipped or with hard, undeveloped tip; flesh slightly whitish toward the center, very juicy, firm, subacid, pleasant flavored, aromatic; good in quality.

A perfect-flowering variety intermediate both in season of bloom and in fruiting. Berries do not retain size in later pickings, variable in color, dull and unattractive in appearance. Not recommended.

Dewdrop.— (H. F. Dew, Albion, Mich.) Said to be hybridized from the old French Jocunda and a wild prairie plant by Mr. Dew. Advertised as an " everbearing " strawberry.

Plants few in number, healthy; leaves large, medium to dark green, rugose; flowers perfect, one and three-sixteenths inches across; petals roundish, entire; stamens short; receptacle large, prominent; fruit-stems long, thick, prostrate, branching; calyx very large, raised, reflexed, leafy, dull green; seeds sunken. Fruit matures late; large to very large, decidedly irregular in shape, strongly furrowed, wedge to irregular conic varying to almost oblate, often necked, variable in color averaging dull, unattractive medium red; apex strongly indented, often green-tipped or hard and undeveloped; flesh whitish toward the center, not juicy, coarse, firm, subacid, mild; fair in quality.

Requires close planting for matted rows as but few runners are produced. A late-ripening variety superior in plant-characters rather than in those of the fruit. Berries unusually large but the shape is decidedly variable, the surface furrowed and the apex often misshapen and inclined to green tips; flavor better than appearance would indicate. Not promising as a variety ripening in June. Its everbearing tendency was not tested as the earlier record was so unfavorable.

Diehl No. 1.— (Benjamin L. Diehl, Danville, Pa.) A seedling of unknown parentage originating with Mr. Diehl in 1908, not yet introduced.

Plants few, large to medium, vigorous, considerably affected with leaf spot; leaves large, rather light green, rugose; flowers perfect, fifteen-sixteenths inch across; petals roundish; stamens numerous; fruit-stems thick, erect, double; calyx slightly raised; seeds variable in position. Fruit matures late; large, with furrowed surface, irregular in shape, varying from wedge to conic, often coxcomb, necked, glossy, attractive medium red; apex slightly pointed; flesh somewhat whitish toward center, juicy, sweet, mild, pleasant flavored; good in quality.

A poor plant-maker; foliage subject to disease. Fruit appeared to have considerable value at the first picking on account of size, attractive color and high quality. All later pickings were disappointing, becoming decidedly variable in size and shape. Surpassed by other varieties.

Dunlap.— (L. J. Farmer, Pulaski, N. Y.)

A well-known variety commercially grown in many localities and considered one of the best medium early or early mid-season kinds. Fully described in Bulletin No. 309.

Dunmore.— (H. J. Schild, Ionia, Mich.) Originated by Mr. Schild in 1905 as a cross between Red Dawn and a seedling of his, No. 19, parentage of which was Red Dawn X Ionia Market. Introduced in 1910 by A. B. Sibert, Rochester, Indiana.

Plants numerous, productive, healthy; leaves slightly rugose; flowers imperfect, season of bloom early, small, averaging seven-eighths inch across; petals overlapping, small, roundish-oval; receptacle broad-conic; fruit-stems short, thick, prostrate, much branching; calyx flat; seeds variable in position. Fruit matures in mid-season; variable in size ranging from large to medium, roundish-conic to wedge, medium to dark glossy attractive red, colors unevenly; apex obtuse; flesh well colored to center, mild; good.

Fruited in 1912 and again in 1914. An early-blooming, imperfect-flowering variety with fairly good plant-habits. Fruit not uniform in size, attractive color, ships poorly; surpassed by other varieties.

Early Jersey Giant.— (J. T. Lovett, Little Silver, N. J.) A seedling of unknown parentage originated in 1907 by Dr. Walter Van Fleet, formerly of Little Silver, N. J., but now connected with the United States Department of Agriculture; introduced by Mr. Lovett in 1912.

Plants medium to numerous, large, vigorous, very productive, healthy; leaves large, rugose; flowers perfect, season of bloom early, one and three-eighths inches across; petals roundish; stamens numerous; fruit-stems medium to long, thick, erect, branching; calyx large, slightly raised, leafy, dull green; seeds slightly raised. Fruit matures early; large, oblong-conic to wedge, slightly necked, dull, rather unattractive medium red; apex pointed; flesh attractive red, not very juicy, coarse, sweet, mild, not high flavored; fair in quality.

An early-blooming, very productive variety maturing early; plant-characters desirable; although of largest size the fruit is unattractive in color, very mild, with but little juice, characteristically long in outline, not high in flavor; surpassed in value by other varieties.

Early Queen.— (E. W. Townsend, Salisbury, Md.) A seedling of unknown parentage originating with E. W. Townsend, Jr., in 1908, and introduced by Mr. Townsend in 1910.

Plants very numerous and vigorous, very productive, healthy; leaves small, rugose; flowers perfect, season of bloom early, one and one-sixteenth inches across; petals large, roundish; stamens numerous, long; receptacle large, prominent, roundish; fruit-stems short, prostrate, branching; calyx depressed, reflexed; seeds small, inconspicuous, sunken. Fruit matures in mid-season; large, blunt-wedge to slightly roundish, with roughish surface, glossy, light red, colors unevenly; apex variable in shape; flesh well colored to center, very juicy, tender, subacid, mild, not high flavored; fair in quality.

Plants very vigorous, increase rapidly. An early-blooming variety. Fruit does not retain size in later pickings, bruises easily, low in flavor.

Ernest.— (E. W. Townsend, Salisbury, Md.) A seedling of unknown parentage originated by E. W. Townsend, Jr., in 1907, and introduced by Townsend & Company in 1911.

Plants vigorous, productive, healthy; leaves glossy; flowers imperfect, bloom in early mid-season, fifteen-sixteenths inch across; petals small, roundish to almost oblate, five to seven in number; receptacle small, conical; fruit-stems variable in length, thick, semi-erect to prostrate, much branching; calyx small, depressed attractive green; seeds variable in position. Fruit matures in mid-season; large to medium, broad, blunt wedge, glossy light red; apex obtuse; flesh well colored to center, mild, not high flavored; fair in quality.

An imperfect-flowering variety maturing its fruit in mid-season. Berries light red, not very firm, of good size and shape but bruise easily and not of highest quality.

Ettersburg No. 71.— (Albert Etter, Briceland, Cal.) Originated in 1905 by Mr. Etter, and introduced by him in 1913. It was secured from seed of Michels Early crossed with Rose Ettersburg.

Plants numerous, vigorous, very productive, with but a trace of leaf spot; leaves slightly rugose; flowers imperfect, season of bloom late, fifteen-sixteenths inch across; petals broadly oval, six to eight in number; fruit-stems branching; calyx small, depressed or flattened; seeds raised. Fruit matures very late; large, roundish, very pale, unattractive red; apex decidedly obtuse; flesh distinctly whitish toward center, very juicy and tender, sweet, pleasant flavored; good in quality.

A late-blooming and late-ripening variety, fruit of which is characterized by its peculiar color — a pale, light red — roundish shape, and whiteness of flesh; although of good quality, too unattractive in color and too soft to ship well.

Ettersburg No. 75.— (Albert Etter, Briceland, Cal.) Originated in 1905 by Mr. Etter and introduced by him in 1913. Parentage the same as *Ettersburg No. 71.*

Plants numerous, medium to large, vigorous, productive, slightly injured by leaf spot; leaves rugose; flowers imperfect, fifteen-sixteenths inch across; petals roundish, five to eight in number; calyx flat to slightly depressed, attractive green, leafy; seeds raised. Fruit matures late, above medium to small, blunt-conic to blunt-wedge, medium red, slightly glossy; apex often pointed; flesh well colored to center, very juicy, medium to firm, sprightly; fair in quality.

Although the plants are productive and the fruit attractive in color the berries average too small to have commercial value.

Ettersburg No. 76.— (Albert Etter, Briceland, Cal.) Originated in 1905 by Mr. Etter and introduced by him in 1913. A Michels Early-Rose Ettersburg seedling crossed with the Cape Mendocino beach strawberry.

Plants vigorous, productive, with but slight trace of leaf spot; leaves dark green, rugose; flowers perfect, one and one-eighth inches across; petals roundish, six to nine in number; stamens numerous, long; receptacle large; fruit-stems long, thick, erect; calyx pale green, variable in position although usually raised; seeds raised, conspicuous. Fruit matures late; above medium in size, roundish to blunt-wedge, often necked, very light, unattractive red; apex obtuse, green-tipped, often hard and undeveloped; flesh whitish toward center, very juicy, tender, sweet, mild, pleasant flavored; good in quality.

At blooming time the many, large blossoms are conspicuous, above the foliage. Fruit, although of good quality, is unattractive in color and ships poorly.

Ettersburg No. 79.— (Albert Etter, Briceland, Cal.) Originated by Mr. Etter in 1905 and introduced by him in 1913. Parentage the same as *Ettersburg No. 76.*

Plants low-growing, with slight trace of leaf spot; leaves smallish, light green, slightly rugose; flowers imperfect, fifteen-sixteenths inch across; petals roundish, five to six in number; calyx large, slightly raised or flattened, very leafy, attractive dark green; seeds raised. Fruit matures late; small, roundish-conic, often necked, attractive, medium to dark red; apex obtuse; flesh whitish toward center, very juicy, sweet, mild; fair in quality.

Plants characterized by their low-growing habit, small leaves and blossoms, and by the large, leafy calyx of the fruit. Berries too small and inferior in flavor to have value.

Ettersburg No. 80.— (Albert Etter, Briceland, Cal.) Originated by Mr. Etter in 1905 and introduced by him in 1913. Mr. Etter makes the following statement in regard to its parentage. "A seedling of Sharpless X Parry of the third generation was crossed with the Peruvian beach or sand strawberry, producing 'Rose Ettersburg.' Rose Ettersburg was crossed with Californica, our native wood strawberry, producing No. 3. No. 3 was crossed with a hybrid from Rose Ettersburg and the Cape Mendocino beach strawberry, one of the resulting seedlings being *Ettersburg No. 80.*"

Plants very numerous, vigorous, productive, considerably injured by leaf spot; leaves medium to large, thick, rugose; flowers perfect, season of bloom late, one and one-eighth inches across; petals roundish, five to six in number; stamens numerous; receptacle large; fruit-stems long, thick, erect; calyx large, flat or depressed, leafy, attractive green; seeds raised. Fruit matures late; large, roundish-conic to blunt-wedge, attractive, light to medium red; apex very obtuse; flesh whitish toward center, very juicy, firm, sweet, pleasant flavored; good in quality.

Plants should be given sufficient room as the runners multiply rapidly. Leaves attractive dark green; blossoms large, with abundant pollen. Fruit of good size which is well-maintained until the close of the season, attractive both in color and shape. Worthy of test on account of the many desirable characters of both plant and fruit although the foliage may sometimes be injured by disease and under certain conditions the light center of the berries may be undesirable.

Ettersburg No. 84.— (Albert Etter, Briceland, Cal.) Originated in 1905 by Mr. Etter and introduced by him in 1913. Parentage the same as *Ettersburg No. 80.*

Plants very numerous, large, vigorous, productive, with but slight trace of leaf spot; leaves medium to large, dark green; flowers perfect, season of bloom late, one and one-fourth inches across; petals nearly round; stamens numerous; receptacle large, somewhat prominent; fruit-stems long, thick, erect; calyx large, flat or raised, leafy, attractive green; seeds slightly raised. Fruit matures late; large, blunt-wedge to conic, often slightly necked, glossy, attractive, medium to dark red; apex obtuse; flesh well colored to center, very juicy, firm, sweet, pleasant flavored; good in quality.

The plants should not be crowded in setting as they multiply rapidly making a wide, matted row. A perfect-flowering, late-blooming variety, especially desirable in localities subject to late spring frosts. Fruit distinctly late and with characteristic dark green leafy calyx. Equal to the best commercial varieties. Worthy of more extended trial.

Ettersburg No. 88.— (Albert Etter, Briceland, Cal.) Originated by Mr. Etter in 1905 and introduced by him in 1913. " A native Fragaria Californica X Wm. Belt." Plants numerous, vigorous, very productive in blossoms, with but a trace of leaf spot; leaves slightly rugose; flowers imperfect, season of bloom early, fifteen-sixteenths inch across; petals nearly roundish; fruit-stems semi-erect. Fruit withered and dried before maturing, together with plants, being unable to withstand sun and drought. No berries ripened.

Ettersburg No. 89.— (Albert Etter, Briceland, Cal.) Originated by Mr. Etter in 1905 and introduced by him in 1913. "A hybrid Marshall X Cape Mendocino beach " strawberry.

Plants very numerous, large, vigorous, productive, considerably injured by leaf spot; leaves large, dark green, slightly rugose; flowers perfect, season of bloom late, one and one-sixteenth inches across; petals nearly round, five to eight in number; stamens numerous; calyx flat or depressed, variable in color; seeds raised. Fruit matures late; large, roundish-conic, dark, glossy, attractive red; apex obtuse; flesh well colored to center, juicy, firm, sweet, mild, pleasant flavored; good in quality.

Plant-habits good except the foliage appears subject to attacks of disease; plants should not be set closely. A perfect-flowering, late-blooming variety characterized by its dark green foliage and by its numerous large, showy blossoms; general appearance somewhat similar to *Ettersburg No. 89.* Appears valuable as a productive, late-fruiting variety; ships unusually well. Worthy of more extended trial.

Ettersburg No. 91.— (Albert Etter, Briceland, Cal.) Originated by Mr. Etter in 1905 and introduced by him in 1913. Parentage the same as *Ettersburg No. 80.*

Plants very numerous, vigorous, unproductive, considerably injured by leaf spot; leaves medium to small, rugose; flowers perfect, season of bloom late, one inch across; petals roundish, five to seven in number; stamens numerous; receptacle medium to small; fruit-stems thick, erect; calyx flat or depressed, unattractive in color; seeds raised. Fruit matures late; above medium in size, roundish-conic, unattractive light to medium red; apex very obtuse; flesh whitish toward center, very juicy, firm, sweet, mild, pleasant flavored; good in quality.

Plants subject to disease; calyx detracts from appearance; color of fruit unattractive; not promising.

Ettersburg No. 93.— (Albert Etter, Briceland, Cal.) Originated by Mr. Etter in 1905 and introduced by him in 1913. Parentage the same as *Ettersburg No. 80.*

Plants numerous, vigorous, much injured by leaf spot; leaves large, slightly rugose; flowers perfect, season of bloom late, one and one-sixteenth inches across; petals nearly roundish, five to seven in number; stamens numerous, rather long; calyx flat or depressed, dull in color; seeds raised. Fruit matures very late; above medium to medium in size, roundish to oblate, dark, glossy, attractive red; apex very obtuse; flesh well colored to center, juicy, firm, sweet, pleasant flavored; good in quality.

A late-blooming and late-ripening variety subject to attacks of disease; although of high quality does not average large enough for commercial purposes.

Ettersburg No. 94.— (Albert Etter, Briceland, Cal.) Originated in 1905 by Mr. Etter and introduced by him in 1913. Mr. Etter states that the parentage is " a white Alpine crossed with a hybrid Rose Ettersburg-Californica."

Plants numerous, vigorous, with but a trace of leaf spot; leaves slightly rugose; flowers imperfect, season of bloom late, fifteen-sixteenths inch across; petals roundish; calyx flat or depressed, dull green; seeds very numerous and prominent. Fruit matures late; large to medium, furrowed, very dark, unattractive red; apex pointed; flesh well colored to center, very firm, tart, not pleasant flavored; poor in quality.

Although of good size, appears worthless on account of seedy appearance of the fruit and undesirable flesh-qualities.

Ettersburg No. 111.— (Albert Etter, Briceland, Cal.) Originated in 1905 by Mr. Etter and introduced by him in 1913. Parentage the same as *Ettersburg No. 80.*

Plants numerous, medium to small, considerably injured by leaf spot; leaves rather small, dark green, rugose; flowers perfect, season of bloom late, one inch across; petals roundish, five to seven in number; stamens numerous; fruit-stems thick, erect;

calyx raised; seeds variable in position. Fruit matures late; large to medium, conic to slightly wedge, necked, attractive, light to dark red, colors unevenly; apex slightly pointed; flesh whitish toward center, very juicy, tender, sweet, mild; fair in quality.

Foliage characteristically dark green, considerably injured by disease. The fruit, although of good size, is too soft to ship well and the quality is rather low.

Ettersburg No. 112.— (Albert Etter, Briceland, Cal.) Originated by Mr. Etter in 1905 and introduced by him in 1913. Parentage the same as *Ettersburg No. 80.*

Plants numerous, below medium in size, medium to unproductive; leaves dark green, rugose; flowers perfect, season of bloom very late, one inch across; petals nearly round, five to six in number; stamens numerous; fruit-stems thick, erect; calyx raised; seeds sunken. Fruit matures very late; large to above medium, conic to slightly wedge, necked, glossy, attractive light to medium red, colors unevenly; apex slightly pointed; flesh whitish toward center, juicy, sweet, pleasant flavored; good to very good.

A low-growing variety with dark green foliage; the latest to bloom of all varieties tested in 1914, hence may have value in locations subject to late spring frosts; although berries are somewhat variable in color and light at the center — the variety is worthy of test for a very late ripening kind on account of its high quality.

Ettersburg No. 114.— (Albert Etter, Briceland, Cal.) Originated by Mr. Etter in 1905 and introduced by him in 1913. Parentage the same as *Ettersburg No. 94.*

Plants numerous, large, vigorous, medium to productive, considerably injured by leaf spot; leaves large, rugose; flowers imperfect, season of bloom late, fifteen-sixteenths inch across; petals nearly roundish, six to ten in number; receptacle large, prominent; fruit-stems long, thick, erect; calyx rather large, flat or depressed; seeds very conspicuous at the apex, raised. Fruit matures late; above medium to small, irregular-conic to blunt-wedge, slightly furrowed, dull, unattractive, light to medium red; apex seedy in appearance; flesh whitish toward center, firm, sprightly; fair in quality.

Although one of the best of shippers, the fruit is too dull in color and does not rank high enough in quality to attract attention.

Ettersburg No. 116.— (Albert Etter, Briceland, Cal.) Originated in 1905 by Mr. Etter and introduced by him in 1913. Parentage the same as *Ettersburg No. 94.*

Plants numerous, small, much injured by leaf spot; leaves medium to small, light to medium green; flowers imperfect, five-eighths inch across; petals broadly oval to roundish, five in number; receptacle large to medium, prominent; fruit-stems thick, semi-erect; calyx small, flat or depressed, light green; seeds prominent, raised. Fruit matures in mid-season; medium to small, furrowed, conic to wedge, dull, unattractive, light red; apex slightly pointed, green-tipped and often hard and undeveloped; flesh whitish toward center, very juicy, firm, tart; fair in quality.

Plants severely injured by disease. Fruit decidedly unattractive in general appearance and inferior in flesh-qualities.

Ettersburg No. 121.— (Albert Etter, Briceland, Cal.) Originated in 1905 by Mr. Etter and introduced by him in 1913. A "hybrid of the wild Alpine crossed with the Cape Mendocino beach strawberry."

Plants numerous, vigorous, productive, considerably injured by leaf spot; leaves medium to small, slightly rugose; flowers perfect, season of bloom late, one and one-sixteenths inches across; petals broadly oval to roundish, five to ten in number; stamens numerous; receptacle medium to small; fruit-stems erect; calyx slightly raised, pale red; seeds raised. Fruit matures late; small to medium, roundish to blunt-wedge, slightly necked, glossy, attractive, dark red; apex obtuse; flesh well colored to center, juicy, firm, sweet, mild; fair in quality.

Foliage uniformly medium in height, with smallish leaves among which are thickly intermingled the rather large, conspicuous blossoms. The greatest defects are in the small size of the fruit and in the lack of high quality.

Fillbasket.— (Vilmorin-Andrieux Nursery Co., Paris, France.)

Plants inferior in size and vigor, considerably injured by leaf spot; leaves small, dark green; flowers perfect, season of bloom late, often one and one-half inches across;

petals broadly roundish to oval, eight in number; stamens numerous, long; fruit-stems short, with long branchlets; calyx large, raised, not reflexed, leafy; seeds prominent, raised. Fruit matures late; medium in size, oblong-conic to wedge, dull, light red, colors unevenly; apex pointed; flesh decidedly whitish toward center, sweet, pleasant flavored; good in quality.

A late-blooming and late-ripening variety inferior both in plant- and fruit-characters.

First Prize.— (E. W. Townsend & Co., Salisbury, Md.) A seedling of unknown parentage originated by E. M. Ruark, Sharptown, Wicomico County, Md., and introduced by Townsend and Company in 1910.

Plants very productive, healthy; leaves large, dark green; flowers perfect, season of bloom early, large, averaging one and five-sixteenths inches across; petals roundish-oval, eight to nine in number; stamens numerous; fruit-stems variable in length, thick, prostrate; calyx large, variable in position, leafy; seeds prominent. Fruit matures early; very large, irregular wedge shape, with furrowed surface, medium to light red, colors unevenly; apex green-tipped, often hard and undeveloped; flesh not very juicy, coarse, subacid, mild; fair in quality.

Not attractive in shape of fruit, coarse in general appearance; surpassed by other more promising varieties.

Four Seasons.— (Vilmorin-Andrieux Nursery Co., Paris, France.)

Plants few in number, small, weak, low-growing, unproductive, healthy; leaves very small, light green; flowers perfect, season of bloom early, very small, averaging one-half inch in diameter; petals obovate, five to six in number; stamens short; fruit-stems very slender, erect; calyx large for size of berry, flattened; seeds prominent, raised. Fruit matures in mid-season; very small, conic, whitish, unattractive; apex pointed; flesh tart, flat; poor in quality.

Plants lacking in vigor and productiveness; foliage unusually small. An early-blooming variety with small blossoms. Fruit small, unattractive, whitish, decidedly inferior both in flavor and quality.

Golden Gate.— (S. H. Warren, Weston, Mass.) Described and recommended for trial in Bulletin No. 309, 1908.

Goodell.— (Sunnyside Nursery Co., Sunnyside, Wash.) Originated by Samuel Goodell, Seattle, Washington, fruiting for the first time in 1906; secured by crossing Marshall with a white seedling. Mr. Goodell reports that the white seedling is a seedling of "Royal Sovereign (English) by the white strawberry Louis Gauthier (French)." Introduced by the Sunnyside Nursery Co., in 1910.

Plants few, small, medium to weak, low in habit of growth, very productive, with but slight leaf spot; leaves small, rugose; flowers perfect, season of bloom early, thirteen-sixteenths inch across; petals roundish, six to seven in number; stamens numerous; fruit-stems medium to short, somewhat slender, prostrate; calyx small, depressed; seeds prominent, detracting somewhat from appearance. Fruit matures in mid-season; above medium to small, blunt-wedge, glossy, attractive dark red; apex variable in shape, often green-tipped, hard and undeveloped; flesh well colored to center, juicy, very firm, sweet, pleasant flavored; good to very good.

Plants not very vigorous although productive; an early-blooming variety, maturing its fruit in mid-season; berries inferior in size, poorly developed at apex, often seedy in appearance but of high quality.

Good Luck.— (W. F. Allen, Salisbury, Md.)

A seedling of unknown parentage found by a Mr. Elwood Pedrick, Cumberland Co., Md., about 1904 and introduced by Mr. Allen in 1907. Described and recommended for more extended trial in Bulletin No. 309, 1908. Fruited for three years since that time and again recommended for testing on account of its high quality; must be picked with care to avoid green tips.

Goodwin.— (H. J. Schild, Ionia, Mich.) Originated by Mr. Schild in 1905 as a cross between Red Dawn and one of his seedlings, No. 19, parentage of which was Red Dawn X Ionia Market. Introduced by A. B. Sibert, Rochester, Indiana, in 1910.

Plants rather few, vigorous, productive, subject to leaf spot; leaves large, very dark green, rugose; flowers perfect, bloom in late mid-season, one and five-sixteenths inches across; petals large, roundish-oval, six to seven in number; stamens numerous; receptacle broad-conic; fruit-stems short, thick, prostrate, much-branched; calyx large, flattened, reflexed; seeds sunken. Fruit matures in mid-season; large, conic but broad at the base, glossy, attractive dark red, colors evenly; apex pointed; flesh well colored to center, very juicy and firm, pleasant flavored, sprightly; very good in quality.

Plants should be set closer than most varieties as but few runners are produced; foliage decidedly dark green in color; worthy of further test on account of good size, shape, color and high quality of the fruit, especially in the earlier pickings.

Gov. Fort.— (T. C. Kevitt, Athenia, N. J.) A cross of Sample X Glen Mary originating with Mr. Kevitt in 1906 and introduced by him in 1910.

Plants few, productive, with but a trace of leaf spot; leaves light green, rugose; flowers perfect, bloom in late mid-season, one and one-sixteenths inches across; petals roundish, five to seven in number; stamens numerous, rather short; receptacle small, roundish; fruit-stems long, thick, nearly prostrate, but little branched; calyx flat; seeds variable in position. Fruit matures in mid-season; above medium in size, long-wedge to long-conic, dull, rather unattractive light red; apex somewhat pointed; flesh whitish toward center, subacid, very mild, not pleasant in flavor; poor in quality.

A mid-season variety of good size, with long-conic or long-wedge apex, not attractive in shape or color, not very juicy, and surpassed both in flavor and quality by other varieties.

Grand Marie.— (H. J. Schild, Ionia, Mich.) Originated by Mr. Schild in 1905 as a cross between Red Dawn and one of his seedlings, No. 19, parentage of which was Red Dawn X Ionia Market. Introduced by A. B. Sibert, Rochester, Indiana, in 1910 as a " fig type " strawberry.

Plants vigorous, productive, with but a trace of leaf spot; leaves large, rugose; flowers perfect, bloom in early mid-season, one and five-sixteenths inches across; petals large, roundish, five to seven in number; stamens numerous short; receptacle roundish-conic, often compressed; fruit-stems medium to short, thick, prostrate, much-branched; calyx large, raised, reflexed, dull green; seeds variable in position. Fruit matures early; very large, faintly furrowed, conic to slightly oblong, necked, glossy, attractive medium red, colors evenly; apex strongly pointed, inclined to green tips; flesh whitish toward center, firm, sweet, mild; good in quality.

A perfect-flowering variety blooming late enough to avoid spring frosts. Fruit characterized by the long, tapering apex and must be picked with care to avoid green tips; a good shipper; berries of largest size and attractive in color; worthy of testing on account of its many desirable qualities.

Granger.— (E. H. Ekey, Steubenville, Ohio.)

A seedling of unknown parentage receiving brief mention in Bulletin No. 336, 1911. Fruited again in 1912 and 1914. Considered worthy of trial on account of attractiveness of fruit and high quality; a large, long-conic or wedge-shaped berry; ships well.

Plants healthy; leaves large, dark green, rugose. Flowers imperfect; calyx flat, leafy; seeds sunken. Fruit matures rather late or in late mid-season; large, long-conic, attractive bright red; apex pointed; flesh well-colored to center, juicy, firm, pleasant subacid, high-flavored; very good in quality.

Helen Davis.— (George W. Davis, Brasil, Ind.) A chance seedling found by Mr. Davis in the summer of 1905 and introduced in the spring of 1911 by the R. M. Kellogg Company, Three Rivers, Michigan.

Plants very numerous and vigorous, productive, somewhat injured by mildew and leaf spot; leaves above medium in size, rugose; flowers perfect, one and one-eighth inches across; petals large, roundish; stamens numerous, long; receptacle large, roundish; fruit-stems medium to long, thick, semi-erect; calyx large, depressed or flattened, leafy, pale green; seeds small, inconspicuous, sunken. Fruit matures in mid-season; large, blunt-conic, rather dull, light red; apex often wedge-shaped; flesh whitish toward center, very juicy, tender, subacid, low in flavor; poor in quality.

A perfect-flowering variety, plants of which are characterized by their number, vigor and height. The most serious defects are in the fruit which is too light in color, too soft for shipping and inferior in flavor.

Hub.— (S. H. Warren, Auburndale, Mass.) Originated in 1901 by George P. Fuller, Melrose, Mass., from a cross between Bubach and Belmont. Introduced by Mr. Warren in 1911.

Plants very few, small, low-growing, healthy; leaves light green; flowers perfect, seven-eighths inch across; petals roundish, five to six in number; stamens numerous; receptacle medium to small; fruit-stems medium to short, rather slender, erect; calyx small, depressed; seeds prominent, raised. Fruit matures in mid-season; above medium to medium in size, regular blunt-conic, glossy, attractive dark red; apex seedy; flesh variable in color, very juicy, firm, sweet, mild, pleasant flavored; good in quality.

A poor plant-maker, low in habit of growth, blooming and ripening in mid-season; unusually attractive in color, of high quality but lacks in size and in productiveness.

Hughson.— (George J. Kellogg, Lake Mills, Wis.) A chance seedling found in the woods in 1906 by Edward Hughson, Lake Mills, Wis., and introduced in 1909 by Mr. Kellogg.

Plants numerous, vigorous, with but a trace of leaf spot; leaves dark green, rugose; flowers imperfect, one and one-sixteenth inches across; petals roundish, five to seven in number; receptacle medium to large, prominent; fruit-stems thick, semi-erect; calyx large, depressed; seeds much sunken. Fruit matures early; large to medium, irregular in shape varying from roundish to blunt-wedge, medium red; apex obtuse; flesh whitish toward center, firm, tart, not high flavored; fair in quality.

Although one of the best of shippers, the fruit is very unattractive in general appearance, rapidly decreases in size as the season advances and is easily surpassed in flavor by other varieties.

Indiana.— (A. B. Sibert, Rochester, Indiana.)

Described and recommended for trial in Bulletin No. 385, April, 1914, and after one more season's fruiting still considered one of the most promising of the more recent introductions.

Ionia Market.— (H. J. Schild, Ionia, Mich.) A seedling of Parker Earle, originating with Mr. Schild in 1895 and introduced by him in 1907.

Plants numerous, above medium in vigor and height, productive, slightly injured by leaf spot; leaves medium to large, dark green, rugose; flowers imperfect, bloom in early mid-season, one inch across; petals small, roundish; receptacle roundish; fruit-stems short to medium, thick, prostrate, much branched; calyx large, raised, leafy, attractive in color; seeds sunken. Fruit matures early; large, conic to wedge, slightly furrowed, somewhat necked, glossy, attractive, medium to dark red; apex pointed, sometimes green-tipped; flesh well colored to center, firm, subacid to tart; fair to good in quality.

An imperfect-flowering variety maturing early, of good size and shape; not equal to the best varieties either in flavor or in quality.

James Todd.— (Henry Schnell, Glasgow, Mo.) A chance seedling found in 1906 by Mr. Schnell and received from him at this Station for testing in 1913.

Plants vigorous, with but a trace of leaf spot; leaves rugose; flowers imperfect, seven-eighths inch across; petals nearly roundish; receptacle prominent; fruit-stems short, semi-erect; calyx small, flat or depressed; seeds variable in position. Fruit matures in mid-season; large to medium, wedge or conic but somewhat irregular in shape, glossy, attractive, medium red; apex slightly pointed, sometimes hard and undeveloped; flesh well colored to center, very juicy, firm, pleasant flavored, sprightly; good in quality.

An imperfect-flowering variety blooming and maturing its fruit in mid-season; one of the best of shippers; berries often a distinct wedge, of good size in the earlier pickings, decreasing in size and in attractiveness of color as the season advances; of doubtful value.

Killarney.— (John F. Nickerson, Chatham, Mass.) A cross between Corsican and Jessie originating with Mr. Nickerson in 1904 and received for testing at this Station in 1911. Not yet introduced.

Plants very numerous, above medium in vigor, productive, considerably injured by leaf spot; leaves large, dark green, rugose; flowers perfect, bloom in early midseason, one and three-eighths inches across; petals large, roundish, seven to ten in number; stamens numerous, rather long; receptacle large, roundish, often compressed; fruit-stems short, thick, prostrate, much branched; calyx large, flat, leafy, unattractive in color, often with tinge of pink; seeds variable in position. Fruit matures in midseason; very large, strongly furrowed, wedge-shape, dull, unattractive dark red; apex wedge-shape, often green-tipped; flesh well colored to center, juicy, firm, pleasant subacid; good in quality.

Plants should be set at a good distance apart as runners multiply rapidly; fruit characterized by its large size and the deep furrows in its surface; rather coarse in general appearance and unattractive in color.

Kittie Rice.— (M. Crawford Co., Cuyahoga Falls, Ohio.)

For history and full description see Bulletin No. 336, 1911. Fruited twice since that date and again recommended for trial on account of high quality.

Late Jersey Giant.— (J. T. Lovett, Little Silver, N. J.) A seedling of unknown parentage originated in 1907 by Dr. Walter Van Fleet formerly of Little Silver, N. J., now with the United States Department of Agriculture, Washington, D. C., and introduced in 1912 by Mr. Lovett.

Plants vigorous, very productive, with but a trace of leaf spot; leaves rugose; flowers perfect, fifteen-sixteenths inch across; petals roundish, five to six in number; stamens numerous; fruit-stems thick, erect; calyx often large, flattened, greenish tinged with red; seeds sunken. Fruit matures late; large, roundish-conic to blunt-wedge, dull, rather unattractive light red; flesh whitish toward center, sweet, pleasant flavored; good in quality.

A very productive late-ripening variety; fruit of large size but lacks attractiveness of color and not one of the best of shippers; the large and often colored calyx detracts from appearance.

Latest Of All.— (Vilmorin-Andrieux Nursery Co., Paris, France.)

Plants small, low-growing; leaves small, dark green; flowers perfect, season of bloom late, one and one-fourth to one and one-half inches across; petals broad-oval; stamens numerous, long; fruit-stems short, thick; calyx large, not reflexed, leafy; seeds prominent, raised. Fruit matures late; medium in size, conic to wedge, dull light red; apex pointed, often green-tipped; flesh whitish toward center, sweet, mild; fair in quality.

A late-blooming and late-ripening variety inferior both in habits of growth and in the character of the fruit.

Laxton's Latest.— (Vilmorin-Andrieux Nursery Co., Paris, France.)

Plants few, unproductive, subject to attacks of leaf spot; leaves small, light green; flowers perfect, one and one-sixteenth inches across; petals roundish, five to seven in number; stamens numerous, variable in length; fruit-stems medium to short, slender, prostrate; seeds raised. Fruit matures late; medium in size, wedge to long-conic, glossy, varying from light to dark red; apex pointed; flesh whitish toward center, juicy, subacid, not high flavored; poor in quality.

Surpassed by other varieties both in habits of growth and in appearance and in flavor of the fruit.

Lea.— (W. F. Allen, Salisbury, Md.) Originated by Thos. J. Custis, Craddockville, Va., in 1907, and introduced by Mr. Allen in 1910.

Plants few in number; leaves small, dark green, glossy; flowers perfect, season of bloom early, one and one-eighth inches across; petals roundish, five to eight in number; stamens numerous; receptacle roundish; fruit-stems medium to long, slender, prostrate; calyx small, flat, tinged with pink; seeds raised. Fruit matures early; small, conic, glossy, attractive red, colors evenly; apex pointed; flesh well colored to center, juicy, tart, not high flavored; fair in quality.

Plants lack in productiveness and fruit is deficient both in size and flavor although attractive in color and a good shipper.

Marshall.— (From bed on Station grounds.)

An old variety fully described in Bulletin No. 309, too well known to require extended description here.

Maryland Prize.— (E. W. Townsend & Co., Salisbury, Md.) A seedling of unknown parentage said to have originated with a Mr. Bell of Towson, Md., in 1908. Introduced by Townsend & Company in 1911.

Plants numerous, vigorous, very productive, healthy; leaves small; flowers imperfect, season of bloom early, seven-eighths inch across, inconspicuous; petals small, roundish, five to eight in number; receptacle roundish-conic; fruit-stems long, thick, prostrate, much branched; calyx large to medium, flat or slightly raised, often leafy, well colored; seeds raised. Fruit matures in mid-season; large, with furrowed surface, conic to wedge, sometimes slightly necked, dull, medium red, colors evenly; apex variable in shape; flesh well colored to center, very juicy, subacid, high flavored; good to very good in quality.

Plant-characters unusually good, especially in yield; an imperfect-flowering, early-blooming variety, maturing its fruit in mid-season. Berries although excellent in size and of high quality are unattractive in general appearance and variable in shape; a fairly good berry but surpassed by the best varieties.

Mascot.— (W. F. Allen, Salisbury, Md.) Plants of Mascot described in Bulletin No. 336, have not proved true to name, although received from the address given above. The following is a description of the true Mascot, introduced by T. M. Hanback, Warrentown, Va., plants of which were received at this Station from W. F. Allen.

Plants numerous, productive, with but a slight amount of leaf spot; leaves rugose; flowers perfect, characteristically large and with crinkly petals, bloom late, one and one-half to one and five-eighths inches across; petals roundish-oval; stamens numerous, long; receptacle large, prominent, roundish; fruit-stems long, thick, semi-erect, branching but little; calyx large, slightly raised; seeds prominent, raised. Fruit usually matures late; large, blunt-wedge to nearly roundish, sometimes slightly necked, dull, rather unattractive medium red; apex pointed, green-tipped, often somewhat seedy in appearance; flesh well colored to center, juicy, firm, sweet, mild, high flavored; very good in quality.

Plant-habits good; flowers characterized by their size and by the crinkly appearance of the petals; a late-maturing variety, of largest size which is well maintained; pleasant flavored and of high quality; surface of fruit often heavily furrowed; care must be used in picking the fruit to avoid green tips; apex not always well formed; worthy of test on account of quality.

Maud Muller.— (E. W. Townsend & Co., Salisbury, Md.) A seedling of the Excelsior, introduced by Townsend & Co., in 1912.

Plants very numerous and vigorous, productive, with but a slight amount of leaf spot; leaves small, smooth; flowers perfect, season of bloom late, one inch across; petals small, broad-oval, five to seven in number; stamens numerous, long; receptacle small; fruit-stems short, slender, prostrate, single; calyx depressed; seeds small, sunken. Fruit matures early; above medium to medium in size, irregular-conic to wedge, often furrowed, glossy, attractive medium to dark red; apex pointed; flesh well colored to center, very juicy, firm, subacid, not high flavored; fair in quality.

A very vigorous, perfect-flowering, late-blooming but early-maturing variety; berries lacking in size, inferior both in flavor and quality.

Missionary.— (E. W. Townsend & Co., Salisbury, Md.) Said to have originated in Norfolk County, Virginia, about 1900. Mr. Townsend secured plants from the originator in 1905 and introduced the variety in 1906.

Plants very numerous, vigorous, healthy; leaves light green, nearly smooth; flowers perfect, season of bloom early, one and one-eighth inches across; petals roundish; stamens variable in number and length; receptacle large, conic; fruit-stems medium to long, prostrate, branching; calyx small, raised; seeds small, inconspicuous, sunken; fruit matures early; above medium to medium in size, blunt-conic, often necked, very dark, dull red, colors evenly; apex somewhat pointed; flesh well colored to center, juicy, very firm, tart, not pleasant in flavor; fair in quality.

Plants develop rapidly; an early variety both in season of bloom and in time of ripening; fruit well shaped and of good color, disappointing in size and too tart for dessert; an excellent shipper.

Model.— (M. Crawford Co., Cuyahoga Falls, O.) Originated by M. S. Hubbell, East Toledo, Ohio. Thought to be a seedling of Wm. Belt. Introduced by the Crawford Company in the spring of 1913.

Plants numerous, medium to large, vigorous, productive, with but a trace of leaf spot; leaves large; flowers perfect, one and three-sixteenths inches across; petals roundish, five to seven in number; stamens numerous; fruit-stems thick, semi-erect; calyx large, raised, leafy; seeds variable in position. Fruit matures in mid-season; large to medium, irregular in shape varying from wedge to conic, often coxcomb, sometimes slightly necked, dull, unattractive light red; apex pointed; flesh well colored to center, juicy, firm, sweet, pleasant flavored; good in quality.

Plant-habits good; although fruit is of high quality, the shape is variable and the color unattractive.

Monroe.— (J. A. Morgan, Scottsville, N. Y.) Fully described and recommended for trial in Bulletin No. 336, 1911. The originator, Mr. Morgan, received the Barry Medal of the Western New York Horticultural Society for this variety at its meeting in Rochester, January 28–30, 1914.

Nanticoke.— (E. W. Townsend & Co., Salisbury, Md.) A seedling of unknown parentage originating in 1907 with a Mr. S. Barkley, Nanticoke, Md. Introduced by Townsend & Co., in 1911.

Plants numerous, vigorous, productive, with a slight amount of leaf spot; leaves dark green, rugose; flowers perfect, season of bloom early, one and one-eighth inches across; petals broad-oval; stamens numerous, rather long; receptacle variable in size, roundish; fruit-stems short to medium, rather slender, prostrate, branched but little; calyx large, flat, strongly reflexed, very leafy, attractive green; seeds much sunken. Fruit matures early; large to below medium, roundish to blunt-wedge, irregular, often furrowed, unattractive, dull light red, colors evenly; apex very blunt; flesh whitish toward center, firm, subacid, inferior in flavor; poor in quality.

Habit of plants good but fruit is decidedly dull and unattractive in color and general appearance and in flavor is easily surpassed by other varieties.

New Discovery.— (L. J. Farmer, Pulaski, N. Y.) A seedling obtained by crossing Warfield with Bubach in 1894 by L. H. Girton, Bristol, Ind., and introduced by Mr. Farmer in 1909.

Plants large, vigorous, very productive, healthy; flowers perfect, large, often one and one-eighth inches across; petals roundish-oval; stamens numerous, short; fruit-stems long, semi-erect; calyx large, raised, leafy; seeds raised. Fruit matures in mid-season; large, blunt-wedge to oval, slightly necked, glossy, attractive dark red; apex obtuse; flesh well colored to center, firm, sweet, mild, pleasant flavored; very good in quality.

A perfect-flowering variety both blooming and maturing its fruit in mid-season. Plant-habits good, especially in yield; fruit of excellent size, one of the most attractive of all varieties in color; worthy of test on account of attractiveness of external characters; ships unusually well; not very juicy, rather meaty, a "fig-type" berry.

Norwood.— (L. J. Farmer, Pulaski, N. Y.) Originated in 1905 by N. B. White, Norwood, Mass., by crossing Corsican with Marshall and introduced by Mr. Farmer in the spring of 1908.

Plants above medium in size, vigorous, healthy; leaves dark green; flowers perfect, often one and three-sixteenths inches across; petals roundish-oblate, five to seven in number; stamens numerous, long; calyx raised; seeds sunken. Fruit matures in mid-season; above medium in size, irregular in shape varying from elongated-conic to wedge, slightly necked, dull light red; apex variable in shape; flesh whitish toward center, not very juicy, subacid, not high flavored; inferior in quality.

On the heavy clay soil of this Station the fruit is a disappointment — irregular in shape, lacking in size and low in quality. Its record must be much better in other locations as it was given first prize by the Massachusetts Horticultural Society in 1906.

Ohio Boy.— (W. S. Todd, Greenwood, Del.) Originated by A. A. Eppert, Amelia, Ohio.

Plants numerous, vigorous, very productive, healthy; leaves light green, smooth; flowers perfect, season of bloom very late, large, often one and one-fourth inches across; petals wrinkled, large, roundish, six to eight in number; stamens numerous, long; receptacle large, roundish; fruit-stems long, thick, semi-erect, much branched; calyx very large, raised, leafy; seeds small, rather prominent, raised. Fruit matures in mid-season; variable in size, wedge-shaped, rather dull medium red, colors unevenly; apex blunt-wedge; flesh juicy, firm, subacid; poor in quality.

A very late-blooming variety with good plant-habits but lacking in size of fruit and also in quality; surpassed by other varieties.

Patagonia.— (Luther Burbank, Santa Rosa, Cal.) Originated by Luther Burbank in 1907. Said to be obtained by crossing the imported Wild Chilian with some of the best American strains.

Plants vigorous, productive, considerably injured by leaf spot; leaves small, dark green, smooth; flowers perfect, one and one-half inches across; petals large, slightly obovate, five to seven in number; stamens numerous, long; receptacle small for the size of the blossom, conical; fruit-stems medium to long, thick, semi-erect, much branched; calyx large, flat or depressed, often discolored; seeds distinctly raised. Fruit matures late; large to medium, blunt-conic to blunt-wedge, dull, unattractive dark red, colors unevenly; apex somewhat pointed, inclined to green tips; flesh distinctly whitish toward center, firm, very sweet, mild; good in quality.

A perfect-flowering, productive variety decidedly unattractive in color of fruit, variable in size, very sweet and of high quality.

Peach.— (L. J. Farmer, Pulaski, N. Y.) A chance seedling found in an abandoned peach orchard in 1888 by L. H. Girton, Bristol, Indiana, and introduced by Mr. Farmer in 1909.

Plants large, vigorous, unproductive, subject to attacks of mildew; leaves large; flowers perfect, often one and one-eighth inches across; petals roundish, six to seven in number; stamens variable in length; fruit-stems long; calyx flat or depressed; seeds sunken. Fruit matures in mid-season; above medium to below in size, wedge to roundish-conic, glossy, medium red; apex obtuse; flesh well colored to center, juicy, firm, pleasant flavored, sprightly, aromatic; very good in quality.

An unproductive variety on the soil of this Station, maturing in mid-season; a berry of high quality, with a large, poorly colored calyx and often green-tipped at the apex of the fruit; surpassed by other varieties.

Peckham Wonder.— (W. U. Peckham, Silver Springs, N. Y.) Found in a meadow in 1907 by Mr. Peckham and received at this Station for testing in 1912.

Plants productive, subject to attacks of mildew; leaves small, light green, somewhat mottled, rugose; flowers perfect, many abortive, one and one-eighth inches across; petals roundish-oval, six to seven in number; stamens numerous, long; receptacle small, roundish; fruit-stems thick, erect, branching but little; calyx large, raised, reflexed, leafy; seeds inconspicuous, sunken. Fruit matures in mid-season; medium in size, long-conic to wedge, somewhat necked, dull, unattractive dark red when fully mature, colors unevenly; apex wedge or somewhat pointed, inclined to green tips; flesh well colored to center, firm, subacid, mild, not high flavored; poor in quality.

Many blossoms failed to set fruit in 1913; fruit ripens in mid-season, but although one of the best of shippers, surpassed in value by other varieties.

Phoenix.— (Charles L. Granby, Naples, N. Y.) A seedling of unknown parentage originating with Mr. Granby in 1906 and introduced by him in 1910.

Plants large, vigorous, productive, healthy; leaves large, dark green; flowers semi-perfect, season of bloom late, one and one-eighth inches across; petals greenish-white becoming yellowish at the base, broad-ovate, seven to eight in number; stamens few, variable in size and length; fruit-stems long; calyx attractive green; seeds prominent, raised. Fruit matures in mid-season; very large, irregular in shape averaging wedge, with furrowed surface, often coxcomb, glossy, medium red; apex variable in shape; flesh whitish toward center, not very juicy, sweet; very good in quality.

A late-blooming variety of good plant-habits maturing its fruit in mid-season. Poor shape appears to be the greatest defect of the berries, but they improve somewhat in the later pickings. Fruit of largest size, must be picked with care to avoid green tips, and notwithstanding its variable shape worthy of test on account of high quality.

Posey.— (Oral Herron, Brazil, Ind.) A chance seedling of unknown parentage found by Mr. Herron in 1910. Received at this Station for testing in 1912.

Plants very numerous and vigorous, productive, subject to attacks of leaf spot; leaves large, light green, smooth; flowers perfect, season of bloom late, one and one-fourth inches across; petals large, broad-oval, usually with crinkly surface, tapering distinctly to narrow, rather long claws; stamens numerous, long; receptacle broad-conic; fruit-stems long, semi-erect, branching; calyx very large, raised, leafy, attractive green; seeds large, usually raised. Fruit matures in mid-season; large, long-wedge, necked, glossy, attractive medium to dark red; apex wedge-shaped, indented, often green-tipped; flesh well colored to center, juicy, firm, subacid, mild; fair in quality.

A perfect-flowering late-blooming, mid-season variety with many vigorous plants; not of highest quality but exceedingly attractive in external appearance; the large, well-colored, dark green calyx in combination with the bright scarlet color of the flesh makes a most pleasing combination; must be picked with care to avoid green tips; may have value when appearance is more desirable than quality.

Productive.— (Samuel Cooper, Delevan, N. Y.) A seedling of Pan American crossed with Autumn. Secured by Mr. Cooper in 1908 and introduced in 1911.

Plants very few, vigorous, productive, healthy; leaves small, very dark green; flowers imperfect, nine-sixteenths inch across, whitish with faint trace of yellow; petals broad-oval, five to eight in number; receptacle small,. roundish-conic; fruit-stems long, slender, prostrate, branched but little; calyx small, much depressed, attractive green; seeds much raised. Fruit matures in mid-season; above medium to small, blunt-wedge to blunt-conic, broad at the base, glossy, attractive medium red; apex obtuse, inclined to green tips; flesh well colored to center, juicy, firm, subacid, mild, not pleasant in flavor; poor to fair in quality.

Plants are characterized by their lack of runners and by the dark green color of the foliage. The fruit is densely clustered about the plants; one of the best of shippers; general appearance good except in size; flavor not equal to the best varieties.

Progressive.— (Harlow Rockhill, Conrad, Ia.) A seedling of Dunlap crossed with Pan American, originating with Mr. Rockhill in 1908 and placed on the market in 1912.

Plants rather few, vigorous, productive, healthy; leaves dark green, smooth; flowers perfect, season of bloom early, one inch across; petals five to six in number; stamens numerous; receptacle small, broadly conic; fruit-stems variable in length, thick, much branched; calyx flat, reflexed, attractive green and often with pink tinge; seeds prominent, raised. Fruit matures early; varies considerably in size ranging from large to small, blunt-wedge, to blunt-conic, glossy, attractive medium to dark red, colors evenly; apex obtuse; flesh well colored to center, firm, subacid, mild; good in quality.

An early-ripening variety making but few runners, variable in size of fruit. The Pan-American blood is evident in the strong tendency to produce fruit during the autumn months.

Prolific.— (Originated on Station grounds in 1899 and disseminated by this Station in 1908, fully described in Bulletins 298, 309 and 364.)

Red Prolific.— (H. J. Schild, Ionia, Mich.) A cross between Ionia and Crescent made by Mr. Schild in 1899 and introduced by him in 1907.

Plants numerous, below medium in vigor and height, productive, healthy; leaves small, smooth; flowers imperfect, season of bloom early, one and one-sixteenth inches across; petals roundish, five to seven in number; receptacle large, prominent, slightly elongated; fruit-stems short to medium, usually single; calyx flat or depressed, often with tinge of red; seeds variable in position. Fruit matures early; large to above medium, conic, medium light red, glossy; apex somewhat pointed; flesh well colored to center, tart, sprightly, not high flavored; fair in quality.

An imperfect-flowering variety both blooming and maturing its fruit early; many leaves tinged red along the margins which are distinctly serrate; fruit picks very easily, the stems being very brittle; a light red, tart berry inferior in flavor and quality.

Repeater.— (W. N. Scarff, New Carlisle, O.)

Plants numerous, small, low-growing, productive, healthy; leaves small, dark green; flowers perfect, season of bloom late, one inch across; petals broad-oval, five to seven in number; stamens numerous, short; fruit-stems variable in thickness; calyx flat or slightly raised; seeds raised. Fruit matures early; above medium in size, blunt-wedge, glossy, attractive medium red; apex obtuse; seeds raised; flesh whitish toward center, juicy, firm, sweet, pleasant flavored, aromatic; fair in quality.

A low-growing, productive variety maturing early, surpassed in size and quality by other varieties.

Rose Ettersburg.— (Albert Etter, Briceland, Cal.) Originated in 1896 by Mr. Etter and introduced by him in 1903. The parentage as given by Mr. Etter is "a third generation Sharpless-Parry X Peruvian Beach."

Plants medium to numerous, with but a trace of leaf spot; flowers perfect, one and one-fourth inches across; petals nearly roundish; stamens very numerous, long; receptacle medium to large; fruit-stems thick, erect; calyx large, flat or slightly depressed, pale green; seeds raised. Fruit matures late; large to medium, decidedly variable in shape ranging from roundish to flattened or blunt-conic, unattractive, very pale light red, colors unevenly; apex obtuse; flesh whitish toward center, juicy, tender, mild, not pleasant in flavor; fair in quality.

At blooming time the flower-stalks are long, bringing the many, large, showy blossoms above the foliage. Although of good size, the berries are decidedly unattractive in color and too soft to ship well.

Rough Rider.— (L. J. Farmer, Pulaski, N. Y.)

A well-known variety fully described in Bulletin No. 309 and recommended as a desirable late variety on account of size, attractiveness and good character of flesh.

Saint Joseph.— Vilmorin-Andrieux Nursery Co., Paris, France.

Plants low-growing in habit; leaves dark green; flowers perfect, season of bloom early, less than one inch across; petals roundish-ovate, five to seven in number; stamens numerous, long; calyx depressed, not attractive in color; seeds variable in position. Fruit matures early; small, blunt-conic to wedge, not glossy, medium red; apex obtuse, flesh distinctly whitish toward center, firm, sweet, mild, pleasant flavored; aromatic; very good in quality.

One of the highest in quality of the early kinds but fruit entirely too small either for commercial or home use.

Schauber No. 701.— (George Schauber, Ballston Lake, N. Y.) A seedling of Nettie open to cross pollination, secured by Mr. Schauber in 1907 and sent to this Station for testing in 1910.

Plants small, rather low-growing, very productive, healthy; leaves small; flowers imperfect, less than one inch across; petals obovate, six to seven in number; fruit-stems very short, variable in thickness; calyx raised; seeds sunken. Fruit matures in mid-season; large, blunt-conic to wedge, rather dull medium red; apex obtuse; flesh well colored to center, juicy, firm, pleasant flavored, sprightly; very good in quality.

Plants, although productive, are inferior in vigor; while the fruit, notwithstanding its high quality, is much too dull in color for commercial use.

Schauber No. 705.— (George Schauber, Ballston Lake, N. Y.) A seedling of Nettie open to chance pollination, originating with Mr. Schauber in 1907 and sent to this Station for testing in 1910.

Plants above medium in size and vigor, productive, healthy; leaves thick, dark green; flowers imperfect, season of bloom late, fifteen-sixteenths inch across; petals roundish-oval, often eight in number, set in a cup-shaped calyx; fruit-stems long, calyx depressed; seeds sunken. Fruit matures late; medium to large, wedge or conic, dull, medium to dark red; apex obtuse; flesh well colored to center, juicy, firm, tart; fair in quality.

A late-ripening variety with fruit irregular in shape, dull in color and too tart for dessert purposes.

Schild No. 2.— (H. J. Schild, Ionia, Mich.) A seedling originated by Mr. Schild in 1905. A cross between Red Dawn and one of his seedlings, No. 19, parentage of which was Red Dawn X Ionia Market. Sent to this Station for testing in 1911. Not yet introduced.

Plants productive, healthy; leaves above medium in size, dark green, rugose; flowers imperfect, season of bloom early, one and one-eighth inches across; petals roundish, overlapping; receptacle large, prominent; calyx small, raised, dull in color; seeds variable in position. Fruit matures early; above medium in size, irregular in shape varying from wedge to oblong, with furrowed surface, rather unattractive medium red; apex irregular varying from pointed to wedge; flesh well colored to center, firm, subacid, mild; fair in quality.

Although plant-habits are desirable the fruit is very irregular and unattractive in shape and coarse in general appearance.

Schild No. 8.— (H. J. Schild, Ionia, Mich.) A seedling originated in 1902 by Mr. Schild and sent to this Station for testing in 1911. Not yet introduced. Parentage the same as his No. 2.

Plants vigorous, productive, subject to leaf spot; leaves large, rugose; flowers perfect, season of bloom early, large, often one and one-eighth inches across; petals large, broad-oval, five to eight in number; stamens numerous, long; receptacle large, often slightly flattened; fruit-stems short to medium, thick, prostrate, much branched; calyx flat, dull green; seeds usually raised but sometimes variable. Fruit matures early; large, blunt-wedge to conic, glossy, attractive medium to dark red, colors evenly; apex somewhat pointed; flesh slightly whitish toward center, firm, subacid, mild; good in quality.

Fruit must be picked with care to avoid green tips; a mild berry lacking distinctive flavor and variable in color; surpassed by other varieties.

Schild No. 10.— (H. J. Schild, Ionia, Mich.) Originated by Mr. Schild in 1902 and sent to this Station for testing in 1911.

Plants very numerous and vigorous, productive, subject to attacks of leaf spots; leaves large, rugose; flowers perfect, season of bloom early; petals large, broad-oval; stamens numerous; receptacle large, roundish, prominent; fruit-stems long, thick, semi-erect, much branching; calyx slightly raised, reflexed; seeds sunken. Fruit matures early; large, roundish-conic to blunt-wedge, slightly necked, glossy, attractive medium to light red, colors unevenly; apex varies from slightly pointed to flattened, often green-tipped; flesh whitish toward center, very juicy, pleasant flavored, sprightly; good in quality.

Plants characterized by their number and vigor; a perfect-flowering, early-blooming variety worthy of test as an early-ripening kind on account of high quality and good size of fruit, although not one of the best of shippers and somewhat variable in color.

Schild No. 12.— (H. J. Schild, Ionia, Mich.) Originated by Mr. Schild in 1902 and sent to this Station for testing in 1911. Not yet introduced. Parentage the same as his No. 2.

Plants few in number, vigorous, above medium in height, productive, with but slight amount of leaf spot; leaves small, dark green, smooth; flowers perfect, season of bloom early, one and one-fourth inches across; petals roundish-oval; stamens numerous, short; receptacle small, a short, broad cone; fruit-stems long, slender, prostrate, branching but little; calyx small, slightly raised, often with tinge of red; seeds sunken. Fruit matures early; above to below medium in size, conic, slightly necked, variable in color ranging from light to dark red, slightly glossy; flesh whitish toward center, firm, sweet, pleasant flavored; good in quality.

Plants multiply slowly; a variety of fairly good habits both of plant and fruit but lacking in size of berry.

Sherman.— (Samuel Cooper, Delevan, N. Y.)

Fully described and recommended as worthy of more extended trial in Bulletin No. 336, 1911.

Sons Prolific.— (D. McNally, Sarcoxie, Mo.) A seedling of Aroma crossed with Bubach originating with James Sons' in 1902 and introduced by the D. McNally Plant and Fruit Company in 1909.

Plants rather few, below medium in vigor, productive, healthy; leaves dark green, smooth; flowers imperfect to semi-imperfect, season of bloom early, one inch across; petals roundish, overlapping, six to seven in number; stamens decidedly variable in number, short; receptacle rather small, a broad cone; fruit-stems long, thick, prostrate, much branched; calyx strongly depressed, attractive green; seeds raised. Fruit matures early; large to medium, irregular in shape ranging from conic to a decided wedge, glossy, attractive medium red; apex variable, often wedge; flesh well colored to center, firm, not high flavored; fair to good in quality.

Plants multiply slowly, not very vigorous; an early-maturing variety attractive in color and size of fruit but variable in shape and not of high quality.

Sweetheart.— (Charles A. Green Nursery Co., Rochester, N. Y.) A seedling of Corsican, seed of which was sown by E. H. Burson, Clifton, N. Y., in 1905. Introduced by Green Nursery Company in the spring of 1913.

Plants numerous, vigorous, very productive, with but a trace of leaf spot; leaves rugose; flowers perfect, season of bloom early, seven-eighths inch across; petals nearly roundish, five to six in number; stamens numerous; receptacle medium to small; fruit-stems thick, erect; seeds sunken. Fruit matures in mid-season; above medium in size, conic, glossy, attractive, light to medium red, colors unevenly; apex pointed; flesh well colored to center, juicy, firm, sprightly, not high flavored; fair to good in quality.

An early-blooming variety maturing its fruit in mid-season; although very productive the fruit should average larger to be of much value commercially; berries very uniform in size, if larger might be of value for the canning factory.

Superb.— (Lewis Roesch, Fredonia, N. Y.) A seedling of Autumn crossed with Cooper, originating with Samuel Cooper, Delevan, N. Y., in 1908, and introduced by Mr. Cooper in 1911.

Plants few, very productive for the number of plants, healthy; leaves small, characteristically dark green, very glossy; flowers perfect, season of bloom early, very small, usually seven-eighths inch across; petals small, roundish, five to six in number; stamens numerous, variable in length; receptacle small, blunt-conic; fruit-stems short, thick, erect, branching; calyx depressed; seeds large, prominent, raised. Fruit matures early; medium to large, blunt-conic, not furrowed, glossy, attractive dark red, colors evenly; apex obtuse; flesh well colored to center, firm, subacid, mild; good in quality.

The stock of plants is increased slowly, but each plant sets a large crop of fruit; an early-blooming, perfect-flowering variety, the berries of which mature early; plants characterized by their fewness and by the dark-green color of the foliage; fruit an excellent shipper, mild, not very high flavored.

Townsend Late Champion.— (E. W. Townsend & Co., Salisbury, Md.) Parentage unknown. Originated in 1908 by E. W. Townsend and introduced by him in 1911.

Plants numerous, productive, healthy; leaves dark green, smooth; flowers perfect, bloom in late mid-season, one and one-eighth inches across; petals small, oval, seven to nine in number; stamens numerous; receptacle large, roundish and somewhat compressed; fruit-stems short, thick, prostrate, much branched; calyx large, depressed, leafy, attractive in color; seeds raised. Fruit matures in mid-season; large, roundish-conic to blunt-wedge, dull, unattractive light red; apex obtuse, indented; flesh slightly whitish toward center, juicy, subacid, mild, not high flavored; fair in quality.

Plant-habits good; a perfect-flowering variety maturing its crop in mid-season; fruit of large size, but dull in color and low in flavor and quality.

Twilley.— (W. F. Allen, Salisbury, Md.) A seedling of unknown parentage originating with W. J. Twilley, Cambridge, Md., about 1906, and introduced by Mr. Allen in 1910.

Plants vigorous, productive, healthy; leaves light green, rugose; flowers perfect, one and seven-sixteenths inches across; petals very large, roundish; stamens numerous, long; receptacle roundish; fruit-stems long, thick, semi-erect, usually not branched; calyx large, raised, leafy, often tinged with pink; seeds raised. Fruit matures in mid-season; large to above medium, distinctly wedge, necked, dull, unattractive light red; apex varies from obtuse to a narrow wedge; flesh well colored to center, firm, very mild, not pleasant flavored; poor in quality.

A mid-season variety of fruit which although of good size is deficient in attractiveness of color and in quality.

Uncle Sam.— (E. W. Townsend & Co., Salisbury, Md.) Plants of this variety were sent to Mr. Townsend in the spring of 1909 by an unknown person in St. Louis, Missouri, with a statement that the plants were a new variety found in a garden. Introduced by Mr. Townsend in 1913.

Plants few in number, productive, healthy; leaves rugose; flowers perfect, season of bloom very early, one and one-sixteenth inches across; petals nearly roundish; stamens medium to numerous; receptacle prominent; fruit-stems somewhat short, thick, prostrate or semi-erect; calyx small, depressed, discolored; seeds variable in position. Fruit matures early; above medium to small, blunt roundish-conic to slight wedge, dull, unattractive dark red, colors evenly; apex blunt; flesh red, juicy, firm, sprightly; fair in quality.

An early-blooming and early-maturing variety, fruit of which averages too small and too dull in color for a desirable commercial variety.

Walnut Stump.— (Sylvanus Gordon, Sergeantsville, N. J.) A seedling of Bubach crossed with Miner's Great Prolific, originating with Mr. Gordon about 1900. Sent to this Station for testing in 1910. Not yet introduced.

Plants numerous, large, vigorous, productive, healthy; leaves characteristically dark green; flowers perfect, season of bloom late, one inch across; petals roundish, six to eight in number; stamens numerous, short; fruit-stems long, thick, erect; calyx large, flat or depressed, leafy; seeds sunken. Fruit matures late; medium in size, roundish-conic, glossy, light red; apex obtuse; flesh well colored to center, tart; fair in quality.

A late-blooming, perfect-flowering variety maturing its crop late in the season; foliage characteristically dark green; berries do not ship well and quality is rather low.

Winner.— (W. F. Allen, Salisbury, Md.) A seedling of unknown parentage originating with W. E. Shoemaker, Laceyville, Pa., about 1909, and introduced by Mr. Allen in 1912.

Plants numerous, vigorous, very productive, healthy; leaves large, light green, glossy; flowers perfect, season of bloom early, large, often one and one-fourth inches across; petals large, oval; stamens numerous, variable in length; receptacle large, prominent, pointed; fruit-stems very long, variable in thickness, very prostrate, branching; calyx large, variable in position, dull green; seeds both raised and sunken. Fruit matures early; large, distinctly wedge and often semi-double varying to long conic, dull, medium to light red; flesh well colored to center, not very juicy, firm, subacid, very mild, not pleasant flavored; poor in quality.

A perfect-flowering variety both blooming and ripening its fruit early; plants characterized by the deepness of the margin serrations of the leaves, by heavy yield, and by the unusual length of the fruit-stems; blossoms show distinctly above the foliage at blooming time; although an excellent shipper and berries of good size the fruit is dull and unattractive in general appearance and inferior both in flavor and quality.

RASPBERRIES, BLACKBERRIES AND DEWBERRIES.*

O. M. TAYLOR.

THE PLANTATION.

Location and soil.— Climatic factors of heat and cold are important in selection of location. These berries are less hardy than strawberries, currants or gooseberries; and plants in exposed locations are liable to suffer. Distance to market must receive consideration because of the poor shipping qualities of the red and purple raspberries and of blackberries. The black raspberry alone stands the wear and tear of handling and shipping unusually well.

All of the berries do well on a wide range of soils. Wet and soggy soils are undesirable as well as stiff heavy clay; and soils too rich in nitrogen should be avoided, as the luxuriant growth resulting on such soils is often immature at the close of the season and is injured during the winter. Both red and black raspberries prefer the lighter, warmer soils, if equally moist, to the heavier clay loams. Blackberries are at their best on a heavier type of soil, a strong, deep, well-drained clay loam being preferable. Dewberries succeed best on comparatively light, sandy loams. Soils for all of the berries should be retentive of moisture, while not over-wet, because the fruit matures during the heat and, often, drought of midsummer.

Preparation of soil.— The plants of these fruits occupy the ground for several years and on this account considerable care should be given to its preparation. It should be well drained either naturally or artificially; and the freer it is from weeds and weed seeds the less the labor needed in future years. Quack grass, if present, should be eradicated, as it is difficult to subdue after its roots become intermingled with the berry plants. Organic materials in the form of manure or in cover crops should be incorporated in the soil on account of their water-holding properties. Deep plowing will not only result in a greater depth of root growth but will conserve moisture. The soil should be made fine and mellow by thorough cultivation before setting the plants.

Manure and fertilizers.— While it is seldom that land is made too rich for strawberries, currants or gooseberries, it may be made too rich for the berries under discussion, resulting in excessive growth followed by winter-injury. Moderate amounts of stable manure or commercial fertilizers or both, applied annually, are usually beneficial. Fertilizers rich in nitrogen should be used with care. The amount of plant food already in the soil is an unknown and variable quantity and exact specifications as to kind and amount of supplemental fertilizers to be used cannot be given. Such questions should be worked out on the different soils by trials of the different materials, taking care to leave checks and to watch closely the resulting habits of growth of the plants and the character of the fruit produced. In making such a test select a portion of the field as uniform as possible in both soil and varieties, divide into plats and apply fertilizers as follows: (1) 400 lbs. acid phosphate per acre; (2) phosphate as above and 200 lbs. muriate of potash; (3) phosphate and potash as above and 150 lbs. nitrate of soda; (4) 8 tons of good stable manure; (5) a plat similar to the others in size left unfertilized as a check. It would be well to duplicate these plats.

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* A reprint of Circular No. 33, January 25, 1915.

The time of application of the fertilizers is important, especially with those rich in nitrogen. If applied too late, the growth may not mature and winter-injury results. Stable manure should be applied in November, during the winter, or in early spring before growth begins; and commercial fertilizers early in the spring so that the plants may not be over-stimulated toward the close of the season.

Propagation.— The different berries may be readily propagated. Red raspberries are usually increased by digging up and transplanting the numerous suckers which develop along the plant row. A part of the horizontal root system should be dug with each sucker, securing whenever possible a good fibrous system. The dormant tops are usually cut back to within a short distance of the root.

Black raspberries and dewberries are usually propagated by means of tip-layers and better plants are secured from two-year-old and three-year-old bushes than from old plantations. The tips are usually ready for layering about the middle of August, depending on the season, at which time they begin to thicken. The tips take root readily if buried from two to three inches deep in moist soil, covering firmly enough to prevent their being whipped about by winds. The tips are usually well rooted by the close of the growing season and are transplanted the following spring, severing the cane about six inches from the tip, thus leaving a convenient handle.

Purple raspberries are hybrids between red and black raspberries and may be propagated, some by suckers and others by tip-layers.

Blackberries may be propagated by suckers and by root-cuttings. Plants from root-cuttings are usually preferred as they have a larger and more fibrous root system. Roots three-sixteenths of an inch or more in diameter are cut into about four-inch lengths, usually in the fall, stratified in sand over winter and are sown three or four inches apart in nursery rows in the spring. By this method good plants may be secured in from one to two years.

Selection of varieties.—All efforts end in failure unless a suitable variety be selected. Nearly all of the 120 varieties of these fruits growing on the grounds of the Experiment Station at Geneva may be characterized by their faults. But few of them have any commercial value. Varieties may succeed in one place yet be failures in other locations. Adaptation should be determined before planting extensively in the commercial plantation. We may determine what varieties to set by observation of the kinds doing well in the immediate locality under apparently similar conditions and by a trial of a few plants before setting extensively. The newer, most promising kinds should be tested in a small way and their local value determined.

Red raspberries are the most popular throughout the State, followed by the black raspberries. Purple raspberries, although very productive and of highest quality when cooked, are unattractive in color and do not ship well. Blackberries are usually in good demand but the acreage grown is comparatively small, largely on account of winter-injury. Dewberries are not planted extensively, partly on account of the labor involved in their culture, the comparatively low yields and their acid flavor until dead ripe, at which time the fruit ships poorly.

Selection of plants.— It is poor economy to set inferior stock. The best plants obtainable should be secured and they should have a well-developed, fibrous root system if the best results are to be expected. The most desirable plants usually come from two- and three-year-old plantations as their vigor has not been impaired and such plants may be expected to be comparatively free from insects and diseases.

Time of planting.— Red raspberries and blackberries may be set either in the fall or spring; suckers of purple raspberries may be set either in the fall or spring, or tip-layers in the spring. Black raspberries and dewberries should be set in the spring. The rows of all plants set in the fall should be back-furrowed or the plants protected with a mulch of coarse stable manure to avoid injury through the heaving of the soil. In the spring the plants should be set as early as the ground will work in good condition. Summer planting of red raspberries is sometimes practiced with good success if weather conditions are favorable. The young suckers of the new growth are dug up and transplanted, during cloudy or wet weather, when from four to eight inches high.

Setting the plants.— Suckers and plants from root cuttings should be set slightly deeper than they grew. Plants from tip-layers should be set rather shallow or if set deeper should be covered lightly at first, gradually filling in during the season as growth develops. The soil should be firmly pressed about the roots. The new shoots, which start early with black raspberries and dewberries, should not be broken off during the process of setting the plants.

The spacing of rows and plants depends on character of soil, on the variety and on the method of culture. The plants should not be crowded. Red raspberries and purple raspberries are usually set in rows 6 to 7 feet apart with plants 2 or 3 feet apart in the row, giving the purple berries the greater distance. They soon form a continuous row. If grown in hills the plants are set about 5 feet apart each way. Black raspberries are set at slightly wider distances than the reds—7 feet by 3½ feet or from 5 to 6 feet apart each way. Blackberries are given still more room—8 feet by 4 feet, or, if kept in hills, 7 to 8 feet apart each way. Larger and finer fruit is usually produced from the hill system, although the total yield may be slightly less. Some growers find the yield about as good by the hill method as when the plants are grown in the matted row. The spacing of plants of dewberries depends on the method of training; if grown in hills and staked, about 4 feet by 4 feet; if trained on a trellis, about 6 feet by 3 feet. After thorough preparation of the soil the land may be marked both ways and a furrow opened one way setting the plants at the intersection of the cross mark with the furrow, or the plants may be set with spade after the ground has been marked.

Cultivation.—The more thorough the cultivation the better the growth. This is especially true as the fruit reaches maturity, for lack of moisture at that time may greatly reduce the yield. Cultivation should begin early and be repeated often enough to maintain a mellow soil condition, and to destroy weeds and surplus suckers. Plants should be hoed whenever necessary. After harvest, the ground should be thoroughly worked and a cover crop sown using about 15 pounds clover seed per acre or 25 pounds vetch or about one bushel of oats or barley. The clover and vetch seed should not be scattered among the canes but should be sown between the rows or it will be difficult to eradicate the following summer. Mixtures of the seed are sometimes used to advantage. A hoed crop may be grown between the rows the first year. Cultivation near the plants should be shallow. Mutilation of roots results in an increase of suckers. The cultivator is usually preferred to the plow but on heavy land the plow must often be used to break up the soil. Late in the season the furrows may be thrown toward the rows, plowing away in the spring or working down with cultivator. The rows of plants should not be allowed to become too wide.

Pruning.—The fruiting canes of all the berries under discussion should be cut out and destroyed as soon as the crop of fruit has been harvested and surplus canes should be cut out the following spring, thinning down to from four to six canes per bush, depending on conditions. This gives more room for the new growth, and may destroy insects and diseases which infect the old canes. No further summer pruning is required with red raspberries. In the spring the canes of red raspberries should be cut back to a desired fruiting height, usually 3 to 4 feet from the ground, depending on vigor.

Black raspberries require more severe pruning than reds. Summer pruning consists in stopping the new growth at a height of about two feet from the ground by removing or pinching off the succulent tip. As the new canes do not all grow at the same time it will be necessary to go over the plantation several times to stop the growth at the desired height. In the spring the lateral branches which develop as a result of this summer pruning are shortened back usually from one-third to one-half their growth, depending on vigor and on the variety. Purple raspberries are usually pruned the same as black raspberries, although some growers prefer to prune as described for red raspberries. The pruning of blackberries is similar to that for black raspberries except that the summer pruning is made at a slightly lower height. If, however, the plants are grown in hills and staked, the new growth is not pinched back in the summer. The vine-like growth of dewberries must be supported by stakes or trellis. The new growth is not pinched back in summer but is allowed to run on the ground along the row and is thinned out, tied up and cut back to the desired length the following spring.

Various forms of trellises are used both for black raspberries and for dewberries in small areas but in the larger and more extensive plantations they are seldom used except for dewberries. A convenient trellis is made by stretching two wires, one on each side of the row, fastened to end stakes and supported at intervals by stakes, the wires being tied together at convenient distances by twine. In other cases one wire or two wires, one above the other, are stretched and the canes tied directly to the wires.

Pollination.— Nearly all varieties fertilize themselves and are usually considered self-fertile. It is generally an advantage, however, to grow more than one variety to extend the picking season and any possible advantage through cross-pollination may then be secured. The dewberry often fails to develop normal fruit, doubtless due to lack of proper fertilization although it is uncertain whether this condition is due to lack of sufficient pollen or to lack of potency.

Hardiness.—In some localities the question of hardiness is of first importance, for only the most hardy varieties will succeed or the kinds set must receive winter protection. Blackberries are usually most tender, while the red raspberries are usually hardier than the black raspberries. Dewberries are seldom injured as from their habit of growth they may readily be laid down and given winter protection. Winter-injury may be caused not only by low temperatures but also by weakened vitality caused by lack of good foliage in summer from disease or other causes, or by a too-rapid growth of wood which is not mature at the close of the season. Over-stimulation of plants should be avoided. Different methods may be used to give winter protection. The canes should be laid down before severe frosts occur after growth ceases in the fall and before the ground freezes and the bending should be as much as possible from the roots and lower portion of the canes. The canes are held in place by covering the tips with earth and in some cases the entire top is buried.

Duration of plantations.— The profitable life of plantations cannot be accurately stated. It depends partly on the variety, on the care given, on the kind of soil, the character of growth, the severity of the winter, and the freedom from insects and diseases. Red raspberries may produce anywhere from four to eight or ten good crops; black raspberries often no more than four crops, sometimes more, usually being removed every six or eight years; blackberries usually last longer than black raspberries, from five to ten years, although half a dozen crops are about as much as can be expected; dewberries are usually slow in developing and usually persist longer than the other berries referred to.

Spraying.—Few, if any, growers spray plants of any of the berries under discussion. The annual pruning out and burning of the old wood tend to reduce insect and fungus troubles. Unfortunately some of the most destructive diseases are not readily or economically controlled by spraying. The most satisfactory method to follow in most cases is to start with healthy plants set in ground that has not produced berries for some time, giving the best of cultural treatment, with frequent renewal of plantations. Further reference to spraying will be found under discussion of insects and diseases.

PESTS.

Insects.—Fortunately but few insects infest any of the berries under discussion. The following are those most commonly found in various sections of the State.

Snowy tree-cricket.— The canes of blackberries and raspberries are often injured in May or early June by the work of pale, greenish-white crickets. These insects make a row, about two inches in length, of punctures in the cane, in which their eggs are deposited. The injury results from the damage to the canes by the punctures rather than by the feeding habits of either the crickets or the larvæ from the eggs. The part of the cane above the puncture either dies or is so weakened as to prevent the normal development of the fruit. The only satisfactory remedy is to gather and burn the infested canes containing the eggs.

Raspberry cane-borer.— Red and black raspberries are attacked by this insect, and blackberries to a less extent. In June eggs are laid singly, by small, dark-colored beetles, in the young shoots about six inches from the tip of the cane. Two rows of punctures encircling the cane are made, one below and the other above the egg. The girdling of the cane results in a withering or drooping of the ends of the young shoots. After hatching, the borer eats its way downward, passing the first winter in the upper part of the cane, reaching the base of the cane the following season. As soon as the wilted tips of the new shoots are observed, they should be cut off well below the girdled spot. The cutting out and burning of all fruiting canes as soon as the fruit has been harvested also aids in the destruction of the older borers.

Raspberry sawfly.— The foliage of all the berries under discussion is at times attacked by this insect. Eggs are laid in May or early June within the tissue, on the underside of the leaves by small, dark-colored flies. After hatching, the larvæ eat away the leaf tissue. They are pale green, thickly covered with whitish spines. The larvæ may be readily destroyed by arsenical sprays applied at the first indication of their presence or, if near harvest time, the plants may be dusted with hellebore or sprayed with hellebore, using one ounce per gallon of water.

Red spider.— In seasons of drought the foliage of raspberries is sometimes seriously injured by minute, yellowish-red mites usually found in large numbers on the underside of the leaves. They suck the juices from the leaves and cannot be controlled by arsenical sprays. Lime-sulphur solution may cause foliage injury. Nicotine extract (40 per ct.) at the rate of three-fourths pint to 100 gallons of water will kill all that are hit by this spray, which must be thoroughly applied, especially to the underside of the foliage. Severe or frequent rains usually keep the mites in check and they are not often numerous enough to require a spray treatment.

Diseases.— There are several diseases which are difficult to control and for which there are no satisfactory remedies.

Anthracnose.— One of the most serious diseases of raspberries and blackberries. Grayish or brown spots or patches develop on the plants, especially on the canes. Black raspberries are most seriously affected and red raspberries least. Bordeaux mixture 4-4-50 will check the disease but the first application must be made when the young plants are six to eight inches high and several applications made at short intervals. The increased yield is usually not sufficient to pay for the cost of spraying. The following measures are suggested. Plants should have a maximum amount of sunlight and air, and should not be crowded. Remove the old wood and the worst of the diseased canes as soon as the fruit has been harvested. Make frequent new plantings on fresh land, selecting the healthiest stock available. Give the best of care, both in cultivation and in feeding the plants, to secure maximum results early in the life of the plantation.

Orange rust.— This disease seldom attacks red raspberries but is most serious on black raspberries and especially on blackberries. The yellowish-green foliage, checking of growth, and the orange-red color of the under surface of the leaves are indications of the presence of this disease. The only treatment is to dig and burn infested plants as soon as the disease is detected.

Cane blight.— This disease attacks both red and black raspberries. The leaves wilt and the canes die as the fruit reaches maturity. The wood becomes discolored in large or small patches, often encircling the cane which becomes brittle and weakened if not killed outright. The only treatment suggested is to cut out and burn infected canes, set only healthy plants, remove fruiting canes at once after harvest and give the best of cultural treatment, making frequent renewals of plantations.

Yellows.— Plants are dwarfish or stunted in growth, the foliage is a mottled, yellowish-green, and the fruit does not mature properly, often becoming dry and insipid. The cause of this disease is unknown and no remedy is suggested except renewal of plantations. Heavy applications of fertilizers or spraying with bordeaux mixture does not check this trouble.

Root-knot or crown gall.— The presence of the disease is indicated by rough, knotty swellings or bunches, usually at the surface of the ground or on the roots beneath. Red raspberries are most affected. There is no satisfactory treatment. The disease often spreads from plant to plant, and is known to spread from raspberries to peaches. All infested plants should be discarded at planting time and plants should not be set on ground known to be infested with this disease.

FRUIT.

Yields, costs and profits.— As with other fruits, productiveness depends on variety, soil, cultural treatment, rainfall, plant food, and freedom from insect or fungus pests. Yields of red raspberries may vary from 1400 to 2000 quarts per acre, black raspberries from 1600 to 2400 quarts per acre; blackberries 2000 to 3000 quarts per acre; dewberries yield considerably less than blackberries.

Costs and profits are much more difficult to ascertain on account of the many and variable factors involved, which must take into consideration cost of manure and fertilizers, cultural treatment given, value of land, amount of labor required to grow the crop and to market it, the business ability of the manager and the price received for the fruit. The yields have already been given. The selling price per quart varies from 8 to 12 cents for red raspberries to 5 to 9 cents for black raspberries, depending largely on the season. Expenses should be kept within bounds so that at the close of the season a profit of from $50 to $150 may be expected. In many seasons, however, the gross income from fruit is in the neighborhood of from $150 to $200. Many growers add to this income through the sale of plants.

Picking and marketing.— The fruit will not arrive at its destination in good condition unless picked and handled with care. The berries are usually marketed in quart boxes which are placed in crates of various sizes, the average-sized crate holding about 32 quarts. Red raspberries should be fully ripe but still firm, with no tendency to overripeness. They deteriorate rapidly after picking and should not be harvested when wet. They soon become soft, dull in color and lose much of their delightful flavor. On account of lack of firmness they are often sold in pint boxes, although some markets prefer quarts. The same rules that apply in harvesting red raspberries apply to black raspberries although the fruit is firmer and will keep longer in good condition. Unfortunately, blackberries are not of highest flavor, but are often quite unpalatable, until dead ripe, at which stage they are too soft for shipping any great distance. The fruit usually turns black before it is ripe and while apparently ready for picking is sour and disagreeable until the berries soften, at which time the flavor is pleasant and refreshing. If left standing in the sun after picking some varieties become reddish-black and deteriorate in flavor. Dewberries are quite similar to the blackberries. The vines are decidedly thorny and unless they have been properly trained the picking is an unpleasant task. They ripen before the blackberries, turning black some time before fit to eat and are not at their best until almost too soft for shipment.

Evaporation.— The black raspberry is the only one of the fruits under discussion which is evaporated to any great extent. The berries are picked by hand or are batted off the bushes into canvas-tray harvesters after they have become fully ripe. The yield of dried fruit per bushel of green fruit varies with the variety and the season. From 2 to 4 quarts of fresh fruit are usually required to make one pound of dried fruit, or one bushel (32 quarts) of fresh fruit will make about 10 pounds dried fruit. The price for evaporated stock varies from 15 to 25 cents per pound. Six cents per quart for fresh fruit is considered a fair price in comparison with the amount received for the dried product.

Varieties recommended for trial.— The following list of varieties is suggestive. They will not all succeed equally well in every place, and some will utterly fail. The list, however, includes those varieties that have made a good record at this Station during recent years, including both older and newer varieties.

Red Raspberries.

Cuthbert.— Late; most popular throughout the State; season long.
Herbert.— Late midseason; larger, softer, more productive than Cuthbert.
June.— Very early; productive, long season; fruit large, ships well.
Marlboro.— Early; plants dwarfish; fruit firm, sometimes crumbles.
Marldon.— Season short, just before Cuthbert; bushes vigorous, very productive; berries large, attractive, bright red; a new, promising variety originated at Experiment Station, Geneva, N. Y. Disseminated in 1909. Plants soon available from nurserymen and growers.
Perfection.— Early; bushes stocky, productive; berries large, attractive red.

Purple Raspberries.

Columbian.— Late; vigorous, productive; firmer than Shaffer.
Shaffer.— Late; fruit larger, softer than Columbian; good canner.

Yellow Raspberries.

Golden Queen.—Late; very vigorous; berries orange or pale yellow, soft, high quality; home use.

Black Raspberries.

Black Pearl.— Early; vigorous, productive; berries large to medium, attractive black. A new variety from the West. Worthy of test.

Cumberland.—Midseason; standard; large, well-colored; desirable.

Diamond.—Midseason; very productive, partial to localities.

Eureka.— Early; good size and color; not of highest quality.

Gregg.—Late; large; lacks productiveness; high quality.

Kansas.—Early; very productive; fruit large, glossy black, sweet; standard.

Palmer.— Early; productive; medium size; standard.

Plum Farmer.— Early midseason; very productive; highly regarded for commercial planting.

Blackberries.

Agawam.— Medium early; long season; hardy, very productive.

Briton (Ancient Briton).— Season medium; very productive, mild, high quality, medium size.

Eldorado.—Medium early; hardy; large fruit; desirable.

Erie.— Midseason; vigorous, fairly hardy; berries attractive color.

Kittatinny.—Late midseason; vigorous but not very hardy; berries large, attractive black.

Mersereau.—Late; not always hardy; large; desirable.

New Rochelle.— Late; old variety; usually hardy; vigorous.

Snyder.— Midseason; usually hardy; berries small.

Dewberries.

Lucretia.—Early; berries attractive black, large, long; the most popular variety.

Premo, Mayes and **McDonald,** should be tested in a small way.

GOOSEBERRIES.*

O. M. TAYLOR.

CULTURE.

Location and soil.— Climatic and soil requirements of gooseberries differ but little from those of currants. They are among the hardiest of all the small fruits, some varieties being found nearly to the Arctic circle. The gooseberry prefers a cool soil of rather heavy, clay-loam type, but quickly deteriorates in sandy soils which become hot and dry. Good air drainage is important, especially with European varieties, which are subject to attacks of mildew.

Preparation of soil.— Moisture is an important essential; yet the plants will not thrive in over-wet soil and many clay-loams require thorough drainage if the plants are to succeed. The soil should contain an abundance of humus. This may be supplied either by stable manure or by plowing under cover crops previous to setting the plants. The gooseberries will root more deeply and more moisture will be conserved if the land be plowed deeply. Thorough cultivation should be given to fit the soil for planting.

Manure and fertilizers.— There is but little danger of the soil being too rich. Gooseberries respond to liberal applications of plant food. Annual applications of stable manure applied during the dormant season or in early spring are beneficial. The kind and amount of commercial fertilizers to use depend on conditions; they are best determined by individual experiments with nitrogen, phosphoric acid and potash, leaving checks so that benefits, if any, may be apparent. The following amounts are suggestive: two to three hundred pounds per acre of nitrate of soda or three to six hundred pounds dried blood applied as soon as the leaves have unfolded; one ton wood ashes or two to three hundred pounds muriate of potash; six to seven hundred pounds acid phosphate; all to be applied early in the spring. Fertilizers will not take the place of humus.

Propagation.— American varieties of gooseberries may be propagated with fairly good results from well-ripened wood of one season's growth, cut into lengths of from six to ten inches as soon as the leaves have dropped; they may be planted at once in nursery rows or tied in bundles and buried, butt end up, in moist sand to callus for a few weeks after which they are planted or they may remain in the sand until early spring. The cuttings are planted deeply leaving but one or two buds above the surface, placing them from four to six inches apart in the row.

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* A reprint of Circular No. 46, December 24, 1915.

The European kinds do not root readily from cuttings and for these mound-layering is resorted to, which method is also followed to some extent for American varieties. The tops of the bushes are cut back severely during the dormant period. This results in the development of many young shoots the following season. About the middle of July the earth is drawn up about and among these shoots leaving only the upper portions exposed. Shoots of most of the American varieties will have developed a good root system by fall but most European varieties require two years to become well rooted. The rooted shoots are cut away from the old plants and are set in nursery rows for one or two years, depending on vigor.

Selection of plants.—Either one-year-old or two-year-old plants may be used. Inferior stock should not be set. Vigorous, well-grown yearlings are usually preferred to older stock, but strong, two-year-old plants are superior to weak one-year-olds. In all cases they should have a well-developed root system.

Time of setting.— Fall-setting is usually preferred for gooseberry plants although they may be planted in the spring with good results if the work is done early.

Setting the plants.— After the plants have been dug the tops are usually cut back and the roots shortened from one-third to one-half in accordance with the amount of growth. The land may be marked both ways, the distance of setting depending on richness of soil and vigor of variety, six feet by four feet being used for small-growing kinds while six feet by six feet will not be too wide for those of vigorous habit. Plants may be set rapidly by plowing a deep furrow one way and setting the plants at the intersection of furrow and mark. Plants should preferably be set slightly deeper than they stood in the nursery row.

Cultivation.— Growth begins early, requiring early working of the soil both to conserve moisture and to make available plant food. It should not be deep near the plants as the root system is shallow. Mulching will not take the place of cultivation. After the crop has been harvested and the soil put in fine condition by cultivation a cover crop may be sown in late July or early August using about fifteen pounds clover seed per acre or twenty-five pounds vetch or about one bushel of oats or barley. Mixtures of these seeds are sometimes used to advantage. A hoed crop may be grown between the plants the first year.

Pruning.— Plants may be pruned any time during the dormant period. The bush form is preferable to the tree form. Five to seven shoots evenly distributed usually make a well-shaped top. The fruit is borne on one-year-old wood and from spurs on the older branches. After the bushes come into bearing some of the older wood should be removed each year to give place to the younger, more vigorous shoots; strong-growing shoots should be headed back as desired. The center should be open, yet not too much exposed to the sun's rays or injury from scald may result, while branches tending to touch the ground should be removed to give a better circulation of air.

Spraying.— Annual attacks of insects or fungus diseases may be expected and for such troubles spraying is a necessity. It is especially important with gooseberries that the foliage be preserved as a protection to the fruit against sunscald.

As a rule, the bushes should be sprayed with a combined insecticide and fungicide soon after the fruit begins to swell and again with a fungicide after the fruit has been harvested. In some localities a dormant spray may be necessary.

INSECTS.

Currant worm.— These worms are usually present each year, destroying the foliage. There are two broods, each having a long season. The worms may easily be killed by an arsenical spray such as arsenate of lead, three pounds to fifty gallons, applied as soon as they make their appearance, usually when the fruit is about half grown. This spray should be combined with a fungicide, either bordeaux mixture, 3–3–50 formula, or lime-sulphur, 1 to 40. Powdered hellebore at the rate of a teaspoonful to a gallon of water is sometimes used.

San José scale.— This pest is too well known to require a description. Spray with lime-sulphur, 1 to 8, early in the spring before the leaves open.

DISEASES.

Leaf-spot.— Gooseberry foliage is attacked by a disease causing brownish spotting on the leaves, which in severe attacks drop prematurely. Remedy: lime-sulphur, 1 to 40, or bordeaux mixture, 3-3-50, applied at time of spraying for worms and again after harvest.

Mildew.— This disease attacks leaves, twigs, or fruit of the European varieties. Patches of moldy, web-like covering appear on the surface, light gray at first, becoming brownish. The fruit when attacked becomes worthless for market and the bushes are stunted. This disease usually yields to repeated applications of potassium sulphide (liver of sulphur), one ounce to two gallons water, applied as the leaves begin to open and repeated every ten days or two weeks. Lime-sulphur is a promising remedy and worthy of test. The mildew has not been so serious in recent years as in the past.

HARDINESS AND LONGEVITY.

Hardiness.— Gooseberries are fully as hardy as currants and healthy plants will withstand low temperatures without injury.

Duration of plantations.— Harvests may be expected for a number of years, much depending on the thoroughness of the renewal process of pruning. Some fields have given good crops for over 20 years but most plantations are discarded after ten or twelve good crops have been secured. Old bushes may sometimes be rejuvenated by cutting off all the canes close to the ground and giving a liberal application of stable manure.

HARVESTING.

Yields and profits.— Gooseberry plants usually bear some fruit the second year from planting and a full crop may be expected the fourth year. Yields vary widely. Mature plants set six feet by four feet may yield from 200 to 400 bushels per acre. The American varieties are usually considered more productive than the Europeans, but this is not always the case.

The amount of profit is dependent on many factors. Value of land, cost of all cultural operations, expense connected with picking and marketing the fruit, and the market price must all be considered. Good crops may be expected annually, the gooseberry being one of the most reliable of all the small fruits. Yields are high but prices vary widely ranging from two to eight cents per pound depending on variety and market conditions. Prices in recent years have been on the decline.

Picking and marketing the fruit.— Most of the gooseberries of this State are picked green and disposed of at canning factories. The market demand is limited. The berries are usually stripped from the bushes, a difficult operation with the thornier varieties, run through a fanning mill to remove the leaves and for the markets are packed in quart boxes or grape baskets, but for canning factories, boxes, trays, or baskets holding from one-third to one-half a bushel are used. The high flavor and good quality of ripe gooseberries, especially of European varieties, are seldom known to consumers as most of the fruit is removed from the bushes before it is ripe. There is danger, however, from sunscald if the fruit is left too long on the bushes.

VARIETIES.

Selection of varieties.— American varieties of gooseberries are grown more extensively in this State than are the European kinds. The leading varieties are Downing, Pearl and Josselyn. There are also a number of hybrids well worthy of attention. The widest variations in size and color exist among the classes. Adaptation should be determined before planting extensively in the commercial plantation. A variety may succeed in one place, yet be a failure in another locality. Downing is the most popular of the American class. Poorman, a newer, red variety, larger in bush and berry than Downing, is worthy of test. Among the European kinds, Industry is the most popular and most widely planted. Chautauqua, a very productive variety, with large, silvery-green berries is fast coming in favor as a commercial sort.

Plants of European varieties as compared with Americans are dwarfer, stockier, with shorter, more upright, thicker branches and with thicker, glossier foliage and the fruit is usually much larger.

AMERICAN GOOSEBERRIES.

Downing.— Standard; pale green; excellent flavor and quality; one of the best.

Josselyn.— Pale red; very vigorous; productive. Berries small.

Pearl.— Resembles Downing.

Poorman.— Large bushes; productive. Berries medium size, pinkish-red. A variety of promise; worthy of test.

EUROPEAN GOOSEBERRIES.

Chautauqua.— Pale green; more vigorous and more productive than Industry; excellent flavor and quality.

Industry.— Productive; dark red; high quality; one of the best.

Whitesmith.— Vigorous; pale yellowish-green; sweet; very good.

TOMATO CULTURE.*

J. W. WELLINGTON.

Soil adaptations.— The tomato thrives on well drained soils. Those which are too heavy and rich have a tendency to produce excessive vine to the detriment of the fruit. A sandy loam of moderate richness and easy tillage is ideal.

Fertilizer.— Well rotted manure is the best of all fertilizers for the tomato and on very poor soils is essential to success. The amount of manure required per acre will depend upon the fertility of the soil, poor types needing a liberal application. In the family garden a forkful of manure placed beneath each plant is ideal treatment. The tomato plant is a rapid and luxuriant grower and needs an abundance of available food. Nitrate of soda has been found by experimenters and practical growers to be very valuable for the tomato crop, both in hastening the growth and in increasing the yield. It is best applied after the plants are set in the field. The nitrate should be distributed near the stem but should not come in contact therewith and should be mixed in with the surface soil. The nitrate treatment will often start tardy plants into strong growth. If the grower must rely on commercial fertilizers alone, he should use at least 500 pounds per acre of a high-grade fertilizer, which application may be reasonably supplemented by the nitrate treatment.

Soil treatment.—The field should be plowed the fall preceding and if manure is to be used it should be applied at this time. The following spring the soil should be thoroughly harrowed and put in good shape. The tomato plants are not set in the field until late May. Therefore w th valuable land it is good practice to grow radishes, lettuce, or early onions on the same plat, allowing space to set plants. This applies only to valuable market garden tracts and small home gardens. The tomato may well take the place of the potato in a good farm rotation.

Good strains.—Late years have produced many highly vaunted strains of tomatoes, the seed of which sells for large prices per ounce and packet. These selections are generally from standard varieties and supposedly produce higher and better quality yields. The Pennsylvania Station † has proved that there is a decided difference between strains and also that those best advertised are not necessarily the best yielders. There are many reliable seedsmen from whom the grower may obtain seed of value. By selecting seed fruits from vines of high yield and good appearance, it is possible to improve a variety greatly in yield and shape. The tomato crosses freely and unless one sort only is grown in a field it will be necessary to bag blossoms before opening in order to secure pure seed.

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* A reprint of Circular No. 34, January 20, 1915.

† Pa. Agrl. Expt. Sta. Bul. 129.

The young plants.—In our State, it is necessary to protect the young seedlings from cold and frosts. The seed should be sown in the hotbed about March 1st, in rows two inches apart. One ounce contains several thousand seeds and so a small packet will be ample to start sufficient plants for the home. When plantlets are about two inches tall, they should be transplanted to a new bed or to flats and set three to six inches apart. Some growers transplant into pots, which is ideal treatment in that each plant has plenty of room for its roots and light for its foliage. The tomato makes rapid growth at this stage and care must be taken to ventilate the beds properly in order to keep the growth sturdy. As soon as safety permits, the glass must be removed entirely to allow the plants to become hardy, covering only during threatening temperature. The housewife may easily start a few seeds near a sunny window and thus raise good plants without much expense. The greenhouse affords an ideal starting place for the tomato. Plants may be raised from seed sown in the open, but are later in maturing fruit. The ideal young plant should be sturdy, healthy green in color, and from six to nine inches high.

Setting the plants.—Early varieties may be set four feet by four feet. Late varieties should be set five feet by five feet and on rich ground will cover the entire surface if set six feet by six feet or even more. Extensive growers employ a transplanting machine for setting the plants. Small fields are set by hand. A spade is a very useful tool for setting. The stem should be set deeper in the soil than it grew in the bed and good pulverized soil should be drawn in about the roots and thoroughly pressed with the feet. By taking care to wet the soil a few hours before taking up the plant, a ball of earth will cling to the roots, and plants thus treated will suffer little setback.

Care of the plants.— The cultivator and hoe are necessary tools for success with the tomato. The cultivator should be used directly after setting and after every rain and the earth kept soft about the plants with the hoe. Nitrate of soda carefully applied about the plants at this stage promotes quickened growth. Commercial tomato growers often lose a considerable portion of their profit by neglecting tillage, which fact is well demonstrated by Indiana Station* experiments. It is excellent practice in the home garden to train the tomato to stakes or trellises, the result being earlier ripening and cleaner, brighter-looking fruits. A trellis of stakes and laths will be found cheap in price and sufficient in strength. Wire trellises are sometimes used in larger plats.

Spraying.— Ordinarily, the tomato does not require spraying, but in damp, muggy weather there may develop conditions wherein spraying is necessary and profitable. The flea-beetle of the potato may riddle the leaves of young tomato plants and is best controlled with bordeaux mixture, which acts as a deterrent. Leaf-spot of the tomato is controlled by the same fungicide.

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*Ind. Agrl. Expt. Sta. Bul. 165.

The crop.— The early varieties are valuable only until late sorts are ripe, for they are usually inferior in quality. The ripening date is variable, early sorts may begin to bear a few fruits in late July— in fact this depends on early starting, favorable location, etc. Fancy and early kinds are handled in small receptacles — the main crop in half-bushel and bushels. Culls and mis-shapes should be discarded altogether. Dirty fruit should be wiped clean and made attractive. Careful packing and facing are profitable operations in the retail trade. Canning factories usually contract for the grower's crop at a definite price per ton — other growers must sell their product at market prices varying greatly with the supply and demand.

Outlook.— The tomato crop is a good year-in-and-year-out investment. With good culture and with right seed the yield may be increased to the neighborhood of twenty tons per acre, which, at a moderate price per ton, would mean good returns. The tomato plant makes a good filler for young orchards. The universal use of the fruits, in preserves, condiments and soups, creates a steady market. The practice of better cultural methods would mean more uniform success to tomato growers.

A FEW GOOD TOMATOES.

Earliana.— Plant small but vigorous; branches slender; foliage sparse; leaves small, light green in color. Fruits medium in size, uneven in shape, often angular, bright red in color. Flavor good. Valuable because of early ripening. For home and market gardens as early variety.

Chalks Early Jewel.— Plant medium in size; branches slender; foliage abundant; leaves medium in size, green in color. Fruits generally smooth, roundish to oblate in shape; solid red in color. Flesh medium firm; flavor good. An excellent second early sort. Grown as main crop in northern localities where late sorts often fail to mature profitably. Very good for the home garden.

Matchless.— Plants large, vigorous. Foliage dark green in color, healthy. Fruit oblate to roundish, regular in shape, bright red in color. Flavor very good, season late, a main crop sort.

Stone.— Plants large, vigorous and healthy. Foliage abundant, dark green in color. Fruits large, oblate to roundish in shape; bright red in color. Flavor excellent. The leading canning and market tomato in sections where the crop profitably matures. Very good for the home garden.

CULTURE OF THE POTATO.*

J. W. WELLINGTON.

Soil.— The potato attains perfection in the cooler soils of our northern states and thrives in an environment of abundant moisture and moderate temperature. This vegetable is adapted to a variety of soils, doing best on a medium clayey loam of good depth and natural richness. Drainage is a very important factor, demonstrated by the fact that the producing potato sections of the country are areas of natural fine drainage. Light sandy loams, if sufficiently fertilized and supplied with humus, produce good crops of superior eating quality. Any well drained soil may be made to produce good yields with proper attention to cultural practices.

Plant food.— Humus is very essential in potato culture. This is commonly supplied in barnyard manure, but in commercial culture the grower is often forced to rely upon the turning under of a leguminous crop for his source of this important material. The lack of humus, with the increasing prevalence of diseases which live over in the soil, has led to the practice of growing the potato in rotation with other farm crops. Maine growers commonly use a rotation of oats, clover and potatoes. The clover is sometimes all turned under, but more often the second crop suffices. Clover, a deep-rooted legume and an air feeder, enriches the soil and makes it more porous. Furthermore, the decaying of the clover has been found to induce a slightly acid condition of the soil which is beneficial in tending to reduce scab injury. Where barnyard manure is used it should be applied liberally to the preceding crop, experience having taught that fresh manure increases scab injury. Where no manure is available, the use of a large amount of high-grade fertilizer is warranted. Heavy applications are broadcasted, small ones should be sown in the furrow and covered by dragging a knotted chain or other device thus preventing the chemicals from coming in direct contact with the seed. Fertilizer should be spread before the final harrowing and preferably a few days before planting. Liberal fertilization is necessary to the production of high yields.

Experiments conducted by this Station for a number of years on different types of Long Island soils proved that applications of over 1000 lbs. per acre of high-grade potato fertilizer were not profitable to the grower. Larger amounts increased the yield to some extent but not sufficiently to warrant their use.

Preparation of land.— If necessity compels the use of pasture or old land, plowing should be done the preceding fall and again in the spring. Deep plowing is essential in order to mellow abundant soil to cover the growing tubers. Harrowing should be continued until the soil is pulverized, this extra work proving a good investment in ease of cultivation and increased yield. Commercial growers use special planters, which open the furrow and drop and cover the seed at one operation. A small plow may be used to open the furrows. Rows should be thirty inches to three feet apart, the hills from twelve to eighteen inches, dependent upon the growing habit of the variety.

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* A reprint of Circular No. 36, January 20, 1915.

Seed.— The potato is propagated asexually, the tubers being commonly, though erroneously, termed seed. The true seed is found in the spherical tomato-like fruits which sometimes develop from the flowers, though generally the flower clusters drop shortly after inflorescence. In purchasing new "seed", the grower should select well-known market varieties and should deal only with reputable merchants and growers even though their price be higher. After once securing good sorts, selection must be undertaken in order to maintain and improve yield and quality. Hill selection at digging time, as contrasted to the old practice of taking seed at random from the bin, is the essence of successful improvement. Seed tubers should be uniform in shape and color and be free from blemishes. Professor Stuart[1] of the Department of Agriculture has published valuable information on the improvement of the potato. It is a common thought that varieties "run out" and that it is necessary to "change seed" every few years. Experimental data presented by Station workers and good growers prove that a variety may be maintained and ameliorated by careful methods and that running out is more often due to the lack of systematic selection and to ignorant practices.

Treatment of seed.— Before cutting, the tubers should be sacked and suspended for two hours in a solution of one pint of commercial formalin to 30 gallons of water, then spread to dry and thereafter handled in clean receptacles. This treatment controls the scab and should be practiced even though the tubers are apparently free. Formaldehyde gas may be used, with proper precaution,[2] in large storage cellars. Tubers showing lesions of Rhizoctonia should be immersed for one and one-half hours in a solution of bichloride of mercury (corrosive sublimate) consisting of two ounces of the substance in fifteen gallons of water. The chemical is a deadly poison and tubers once treated should be planted immediately. This is also an efficient treatment for scab and were it not for the dangerous nature of the material would be the better solution for common use. Large seed tubers should be cut into two or more pieces, small tubers may be planted whole. The seed tubers should be kept in a cool cellar so as to retard the growth of the sprouts.

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[1] W. Stuart, "Good Seed Potatoes and How to Produce Them." U. S. Dept. Agr. Farmers' Bul. 533.

[2] "The Injurious Effect of Formaldehyde Gas on Potato Tubers." Stewart and Gloyer. N. Y. Agr. Exp. Sta. Buls. 369 and 370.

Planting.— Early varieties should be planted as soon as the ground is warm and can be properly prepared. Main-crop varieties are sown later when danger of frosts is well past. Young plants may be protected from frosts by covering lightly with soil. The furrows should be about six inches deep. In small fields and gardens hand planting is practiced and seed pieces are dropped at as nearly equal distances as is possible with rapid work. The furrows may be filled by hoes or by a horse cultivator properly equipped. In commercial operations this work is simplified by the use of the potato planter.

Care of growing crop.— The field should be harrowed frequently from planting time until the young plants begin to appear. In weedy fields and in soil that has a tendency to bake it is often advisable to harrow with a fine toothed weeder once or twice while the plants are yet small. After this the soil must be kept mellow by frequent tillage and at least one or more hoeings. At the time the vines start spreading, the rows should be hilled slightly with either a special ridger, a cultivator with hillers, or with hoes. This is done to protect the young tubers from exposure to the sun after the vines die down. From this point tillage ceases, as the vines soon cover the ground in a mass.

Spraying.— The value of potato spraying is now beyond question and is recognized by all better growers. Concise directions for spraying are given in the following extract from Bulletin 349[3] of this Station. "Spraying with bordeaux mixture should be commenced when the plants are six to eight inches high and repeated at intervals of 10 to 14 days throughout the season, making five to seven applications in all. Some poison should be added to the bordeaux whenever bugs or flea beetles are plentiful. The spraying should be very thorough — the more thorough the better." Bordeaux mixture is a standard fungicide, directions for making of which may be had from this Station. The poison used may be either arsenate of lead or paris green, the first more enduring on the vines and the second quicker in action. The fungicide controls early and late blight and other foliage maladies, the insecticide saves the plants from almost certain defoliation by the Colorado beetle.

Harvesting.— Early varieties are dug when the vines turn brown and tubers are of useful size. Later varieties are more often killed down by frosts and do not reach full maturity. If possible, good sunshiny weather should be chosen as time for digging. Large fields are dug with special digging implements, small fields with a plow or with hand tools. The tubers should dry on the ground, then be bagged or crated and taken to sheds for grading. Misshapen and undersized potatoes should be discarded. Potatoes are marketed in barrels, two-bushel bags and bushel crates.

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[3] Stewart, French & Sirrine. "Potato Spraying Experiments." N. Y. Agr. Expt. Sta. Bul. 349.

Storage.— Potatoes are often profitably stored until after the rush season. Community storage is ideal, in making use of a specially constructed building wherein temperature and moisture may be better controlled and where the product may be advantageously exposed for sale. The farm cellar is good, if safe from frost and not equipped with furnace or boiler. A root cellar is not expensive and should be on every farm.

The potato is the most important vegetable and supplies a large part of the world's food. It is, therefore, especially reasonable that the grower should practice every effort toward the upbuilding of the industry.

A FEW OF THE BETTER VARIETIES.

Irish Cobbler.— Early; white; roundish-oblong with tendency to irregularity in shape; quality good; valuable for early home and market purposes.

Early Rose.— Early; pink to rose in color; tubers long, slightly tapering and flattened; flesh white; quality good; valuable for early home and market purposes wherever a reddish skin potato is held in esteem.

Rural New Yorker.— Late; white skin and flesh; tubers roundish-oval to quite oblong; quality very good. Standard main crop variety.

Green Mountain.— Late main crop variety; tubers roundish-oval and thickened; sprouts white; quality very good. Adapted to northern counties where climatical conditions are more favorable.

ONION CULTURE.*

J. W. WELLINGTON.

Climate.— The onion thrives best in a climate which affords moderate temperature and abundant moisture during the first stage of the plant's growth, developing gradually into a season of increasing heat and accompanying drying of soil and atmosphere. This vegetable is grown throughout the entire United States but the producing sections are in the north. New York is one of the leading onion states.

Soils.— Soils containing a superabundance of decaying nitrogenous materials are particularly favorable to onion growing. The muck areas are of this nature and when properly drained are unexcelled in that they present a soil level in situation, containing abundant moisture and of easy tillage. Heavy clay and rough gravel types should be avoided as they are difficult and expensive to properly prepare and till. The sandy loams of old river bottoms afford an ideal situation for onion growing. In New York State the onion is produced largely upon the muck soils of which there are extensive pockets in the central and western parts of the State. Mucks are largely composed of nitrogenous materials and, therefore, contain an almost inexhaustible supply of humus. Not all mucks are adapted to vegetable growing. Those derived from hard wood growths are generally excellent, while those resulting wholly from rotted Tamarack or shrubby vegetation are usually of little value. Prospective purchasers or owners contemplating the growing of vegetables on muck should consult with experienced growers before investing to any great extent in land or drainage.

Drainage.— The muck deposits are found in low swampy areas where natural drainage is almost entirely lacking. Artificial drainage is usually necessary and is generally accomplished by digging a big main ditch through the swamp and leading to a lower level. Lateral drains are then constructed to the main ditch. Covered tile drains are greatly superior to open ditches, not only exerting a saving in land but also doing away with grass and weeds which harbor insect and fungus pests. A proper system of drainage enables the grower to work his land quite early in the spring and assists in keeping a constant water level by carrying off excessive rainfalls. During the summer droughts these drains may be used as a basis for a subirrigation plant. Without some method of drainage vegetable growing on the muck lands would result in almost certain failure.

Air drainage is also important with the onion crop; that is, small fields should not be surrounded on all sides by high trees but should have open exposure to currents of air.

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* A reprint of Circular No. 40, April 30, 1915.

Crop rotation.— The onion is commonly grown in rotation with lettuce and celery although with proper fertilization it may be grown continuously on the same soil. A two-year rotation consisting of onions one year and lettuce intercropped with celery the next is a common practice.

Preparation.— The soil should be plowed in the fall preceding the seeding of the onion and if manure is to be applied it should be spread at this time and harrowed into the soil. The disc harrow should be brought into use as early in the spring as ground can be worked. Commercial fertilizer should be sown at this time so that it may be thoroughly incorporated with the soil. Some fine cutting and smoothing tool should be used for bringing the soil into a condition of almost perfect tilth. Only sufficient area for the day's planting should be prepared at one time so that the seed bed may be moist and favorable for a quick start.

Fertilizers.— The onion requires abundant food in order to promote a profitable bulb growth. The amount of fertilizing materials used per acre is large. Since the value of good onion land is high and the cost of culture very large, the growers cannot allow shortage of food to be the limiting factor to success. Potash and phosphoric acid are needed on the muck soils and it is a common practice to use commercial fertilizers having a high content of these constituents. A visit to a prosperous onion section and discussion with the growers as to fertilizer problems would be of great assistance to the beginner.

Propagation.— Onions are propagated in three ways, first by seed, second by segregation of bulb into small bulblets, and third by the production of small bulblets at the top of the blossom stalk instead of flowers and seeds. Commercial onion culture is almost altogether dependent upon the first division, that of seed production.

Onion sets.— Sets are little onions produced for the purpose of planting out again the following season, thereby promoting early ripening and securing of high prices. Ordinary commercial varieties are grown for this purpose. The production of sets has become a regular business in certain sections of the country, so great is the demand for this form of seed. The method of growing consists in the sowing of a tremendous excess of seed thus forcing the bulbs to remain small. The rows are placed about a foot apart and from 75 to 100 pounds of seed used per acre. Size of set is very important, those too large running directly to seed and those too small making inferior bulbs. Proper diameter should be between one-half and one-third inch. The growing of onions from sets is adapted to home and small market gardens. The labor cost of setting is tremendous.

Seed.— Onions are commonly grown from seed sown directly in the field. The seed itself is produced from full sized bulbs which have been carefully stored during the winter and set out again the following spring. The growing of seed is an industry in itself and is generally in the hands of specialists. Onion seed as offered upon the market is often low in vitality and of doubtful varietal purity, hence the prospective grower should purchase only from reputable seed producers. Strains of standard varieties have been selected which yield a very high percentage of good shaped bulbs. It would be well for the grower to make tests of strains one year ahead of extensive field plantings.

Treatment of seed.— One of the serious fungus troubles of onion, namely smut, may be largely controlled by proper treatment of the seed. Immersion of the seed for twenty minutes in a solution consisting of one ounce of formalin to one gallon of water is recommended. The difficulty of this method is in the proper drying of the seed afterward so that it may easily pass through the seeder. Certain seed drills are equipped with a formalin tank thus affording a means of wetting the seed as it leaves the hopper and avoiding all the trouble of drying. Another effective and common treatment for smut is that of sowing with the seed a mixture of sulphur and slaked lime. The proportion generally used is that of 100 pounds of sulphur to 50 pounds of lime. An ordinary fertilizer attachment to the seeder is used for distributing the fungicidal mixture. These preventive methods are successfully practiced by many onion growers.

Planting.— Onion seed should be sown as early in the spring as the ground may be properly prepared. The seed is sown with hand drills and in rows about one foot apart. From three to six pounds of seed are required per acre depending on the viability of the seed and whether thinning is or is not to be practiced. There are gang seed drills on the market which sow sev ral rows at once, but the single row drill is in more common use. The drill sows and covers the seed at one operation. The rows should be made as straight and as evenly spaced as possible both for the sake of appearance and for enabling easy passage of the wheel hoes.

Cultivation.— Tillage is the keystone of success in the onion industry and at the same time is the most expensive operation connected therewith. The wheel hoe should be brought into action shortly after the seedlings appear and the blades set so as to come as near as possible to the young plants. A two-wheeled hoe is generally used early in the season and later, when the plants are well established, the single-wheeled type is found more satisfactory. Weeds will appear between the plants and necessitate two or more hand weedings, an operation which is both laborious and costly but of absolute necessity. Wire-toothed weeders are offered which are built to remove the weeds between plants. Their value, if capable of doing this work, would be incalculable to the onion grower but as yet have not had sufficient trial to warrant their recommendation. The scuffle or push hoe is used for removing weeds among the rows of nearly matured crops. Onions should be tilled frequently during the first few months of their growth, sufficient at least to keep the soil loose and friable about the plants.

Thinning.— Onions are thinned at the first or second weeding, when the seedlings are small and have not begun to crowd one another. In thinning, the poorer plants are removed and a space left between those remaining which results in a large percentage of smooth bulbs of first grade. Thinning is an expensive operation and most growers do away with the task by planting less seed per acre and thus securing a lighter stand.

Disease and insect troubles.— Onion mildew or blight is a serious malady of the onion, occurring during the hot, muggy weather of midsummer and spreading with great rapidity. The manifestation is a downy, violet mass of spores which develops into a serious blighting or withering of the leaves. To prevent this disease spray with 5-5-50 bordeaux mixture, to every 50 gallons of which has been added one gallon of resin-sal soda sticker. Treatment should begin when the plants show three leaves and be repeated every ten days until crop is harvested. It is practically useless to begin spraying after the disease gains a foothold.

The onion maggot, larva of the imported onion fly, is a serious pest in some locations. Crop rotation has been advised as a means of control. Dr. Severin of Marietta College, Ohio, is experimenting with poisoned sweet baits as a remedy for this insect and his work to date, though incomplete, offers promise of success.

The onion thrip is a minute sucking insect which attacks the leaves causing them to turn gray, gradually wither and die. This is a very serious pest where present in onion fields and may be best controlled with applications of dilutions of " Black Leaf 40 " or other similar tobacco extracts.

Cut worms are often destructive to young onions and if abundant should be combatted with poisoned bran mash made in the following proportion. One pound of paris green mixed thoroughly in 35 pounds of bran and the whole mixture moistened with molasses water. This material should then be thinly scattered among those rows which are seriously attacked.

Scallions or " bull necks " are those plants which do not ripen properly in the fall but maintain a rank growth after the normal bulbs have commenced drying. This condition of growth may be due to several factors — poor quality seed, excessive late summer rains, spring applications of fresh manure or late sowings of commercial fertilizers. All these factors, with the exception of the moisture, may be averted by proper attention to details.

Harvesting.— In order to secure good keeping bulbs the onions should be allowed to ripen thoroughly in the field. In favorable seasons the onion will thoroughly mature and the tops fall naturally to the ground, in which stage the bulbs are ready for the harvest. There are, however, years in which growth continues later than is desirable and at such time the grower may hasten the maturity of his crop by rolling a light barrel or roller back and forth over the field. This operation tends to stop growth and encourage ripening. The onions are commonly pulled by hand and at the same time thrown into windrows a few feet apart. The plants are allowed to lie in these rows for a few days to encourage further drying. In case of rains the rows should be worked over with a wooden rake. Topping, the cutting away of the leaves to within an inch of the bulb, is generally done in the field and with the aid of sheep shears. Topping machines are in use but have not yet reached a perfected state. After topping, the bulbs are shoveled with potato scoops into slat crates which are then piled into narrow tiers of forty or fifty each. Boards are then placed over the top in order to keep out rain. Care should be taken to keep all possible rubbish out of the crates, thus affording best possible air circulation among the bulbs. Curing sheds are in use in certain sections of the country and consist simply of a tight roof and widely ventilated sides.

Onions should be graded before putting them upon the market. This work is quickened by pouring the bulbs upon a sorting rack through which rubbish may drop and from which inferior bulbs may be readily singled out and put in separate receptacles.

Storage.— The first principle of onion storage is that all bulbs placed in the house should be sound, well ripened and dry. The storage of an onion crop is a task of no small magnitude and growers should cooperate in the erection of proper buildings for the purpose. Such a house would rapidly pay for itself in that onions usually take a sharp rise in value after the first rush of sales is past. The onion storage house of C. C. Mowris at South Lima, N. Y., is an example well worthy of observation and study. Onions are commonly stored in bushel crates and space left between tiers so as to allow best possible ventilation. The small grower should take advantage of commercial onion storage houses. Onions may be stored by freezing them solid and keeping them so with a covering of dry hay or straw. This operation, though possible, is not practicable and is accompanied with a great risk of final disaster.

Types.— There are a great many types of onions grown in the State but only a very few are of extended use. The giant forms as Prizetaker, Gibraltar and Ailsa Craig are grown to a limited extent in home and smaller market gardens. These varieties should be started under glass and transplanted to the field in order to obtain good market size. Their growing on a limited scale is a profitable enterprise.

Potato and top onions are used in the growing of bunch onions for early spring market and to a limited extent are also used in growing full sized bulbs. The potato onion bulblets may be sown about the first of October. The bed should be covered with strawy manure at the approach of hard freezing weather. Growth starts in very early spring and shortly after the mulch is removed, the plants will attain market size. Sets of common varieties are also used for producing bunch onions and should be sown very early in the spring when grown for this purpose.

The varieties of onions used in commercial field culture are few in number and standard in quality. Some of the more important are as follows:

Danvers.— The standard yellow variety. Bulbs roundish approaching globular in shape. Texture firm and solid. Flavor excellent. A most valuable shipping and market sort.

Wethersfield.— Purplish-red in color. Shape roundish-oblate. Size large to very large. Flesh firm, solid and purplish-white in color. Quality very good. A valuable red variety.

Southport Yellow, White, and Red Globe. — Three varieties extensively grown in various sections of the northern onion belt. The white variety should be grown only in sections where a white bulb is desired and where conditions are favorable to its culture.

RHUBARB CULTURE.*

C. C. CARSTENS.

Climate and soil.— Rhubarb is naturally a cold-weather plant and is expected to make a luxuriant growth of leaves with thickened leaf-stalks early in the spring, consequently it must feed in a quick-responding soil. Locations where snow and ice are liable to linger during the spring should be avoided. A site on early ground, with a southern exposure and a slight slope for drainage, is desirable. A rich soil, mellow to a considerable depth, is of great importance for a good commercial plantation. The site should be well drained, but the soil rich in humus and of a retentive nature, so as to retain the large amount of moisture required by the rapid-growing stalks.

Preparation of soil.— The soil should be well prepared before starting the plantation, especially if not thoroughly mellow, by growing a crop like potatoes on the site for a season, with liberal amounts of stable manure to supply humus and enrich the soil. The soil can hardly be made too rich. Deep stirring of the soil before planting is essential — the deeper, the better. Sites infested with quack grass should be avoided or thoroughly cleared of this bothersome weed before setting rhubarb.

Propagation.— Rhubarb propagates by root divisions or by seed. The root method is considered by some to be an expensive one, but is highly desirable in order to secure uniformity of the product. Where the grower already has a number of healthy plants growing on his place he may dig them up and separate the root clumps which have formed at the base of the plants and start the new plantation from these without great expense. In dividing the roots care should be taken to obtain a piece of the crown on each division of the root clump. Strong, healthy and vigorous roots should be selected for planting and poor, half-developed roots should be discarded, in order to give the plantation a good start under favorable conditions.

Some growers prefer to propagate from seeds because these may be obtained so much cheaper than roots. But rhubarb plants grown from seed require one year longer to come to maturity than those grown from roots; that is, it will require three years from the time of sowing for the plants to become firmly established in the ground. The first harvesting of leaf-stalks will thus be delayed until the spring of the fourth year. Also, rhubarb does not always come true to type from seed, only about 15 per ct. of seedlings usually being true to the variety, and therefore more or less variation among the plants, as to size of stalk, etc., may be expected.

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* A reprint of Circular No. 38, March 20, 1915.

This irregularity can be only partly avoided by selecting the plants having the most uniform characteristics. The seeds are sown early in the spring and are usually drilled in rows about 18 to 36 inches apart and about 1 inch deep. About one-half ounce of seed should be used for 100 feet of drill. The young plants should be thinned to about 8 or 10 inches apart in the row. The year following the seeding, when the plants are one year old, they are ready to be set in permanent positions.

Planting.— When the site of the plantation has been thoroughly worked and the ground is mellowed to a good depth it is ready for planting. This is usually done in the spring although successful results may be obtained from fall setting. A heavy application of manure at the time of planting is desirable. This may be placed directly on the hill but it is best to mix it with soil when it is put near the roots. The roots should be set deeply if they are to remain as a permanent plantation so that the crowns may be covered with from 2 inches to 3 inches of soil. The distance for planting varies somewhat with the variety since some varieties grow larger than others. Where cultivation is to be only in one direction the rows may be from 4 to 6 feet apart with the plants 3 feet apart in the rows. When planted 4 feet apart in the rows with the rows 4 to 6 feet apart the plantation can be cultivated both ways.

Cultivation and fertilization.— Rhubarb seedlings and young plants should be given good surface cultivation throughout the season, chiefly to prevent the growth of weeds and to keep the surface mellow. It should not be deep enough to injure the roots. Every fall a heavy coating of well-rotted stable manure should be applied. This free use of manure should not be neglected, for therein lies one of the secrets of success in rhubarb culture. Commercial fertilizers will not take the place of stable nanure. In the spring the manure is forked away from the plants and a thorough cultivation given the land, turning the manure under. Some growers have found it profitable to use nitrate of soda in addition to stable manure, scattering it, in the spring, on either side of the row at the rate of about 100 pounds to the acre. After turning under the manure cultivation is withheld, in the case of a mature plantation, until the harvesting time is over to avoid injuring the crop. Cultivation is resumed as soon as the stalks are harvested, to mellow the soil and keep out weeds.

Renewal.— If after four or five seasons the plants appear to be running down, it is generally an indication of too great root growth; and the root clumps should be divided. These may be dug up in the fall; or some of the roots chopped off by spading around the plants. The surplus roots cut off, if a portion of the crown be left on, may often be sold profitably. Some growers simply plow up close to the plants in the fall and thus cut off some of the roots from the clumps. This need be done only once in every four or five years when the plants seem to require it.

Harvesting the crop.— In root-set plantations the plants should be in a sufficiently vigorous condition in the spring of the third year to permit harvesting a light crop. Only the largest, full-grown leaves should be taken — generally the outer leaves of the plant. All of the younger leaves, which are usually toward the center, should be left to maintain the plant through the summer; and at no time should anywhere near all of the leaves be removed. In picking, pull straight upward and at the same time apply a slight sidewise twist to the stalk, which should separate readily from the crown without breaking and without injuring the plant. The stalks may be dropped in small orderly piles on the ground, and later gathered up in baskets or in carts and taken to a convenient place to be prepared for market. Flower or seed stalks should be cut out as fast as they appear.

Preparing for market.— If the rhubarb is intended for market the dirt on the stalks should be washed off or removed with brushes. The leaf blade should always be cut off, for unless this be done the stalks wilt more rapidly and soon lose their fresh appearance. The stalks are then tied in bunches of from 2 to 5 stalks; or, for local market, 3 or 4 to the bunch with the bunches tied into bundles of a dozen bunches each. Ordinary twine or raffia is used for tying. Tying is done chiefly for convenience in handling but the neat appearance and the uniformity of the bunches add to the selling value of the product. If rhubarb is to be shipped the bundles are sometimes wrapped in paper and packed in crates or boxes of convenient size for handling. When marketing early in spring it is advisable to ship by rapid and safe transportation to avoid danger of freezing.

Forcing.— Forcing of rhubarb has become quite common with many growers and various means are employed to produce a winter or early spring crop. Wholesale growers usually have a specially constructed cellar which is heated by a stove or by steam. The space under greenhouse benches is sometimes used to good advantage for this purpose. The process of forcing is simple, as heat and moisture are the two requisites. Rhubarb does not require light for stalk growth, consequently a dark cellar or shed will do as well as a sunny greenhouse, if the right amount of heat can be supplied. For family use the roots may be planted in a box and placed in a warm cellar or attic. On a larger scale one may use all available space in the cellar or any shed which can be heated with a stove. Deep earth is not necessary for forcing and the soil can be placed on the floor. Root growth is very slight during the forcing process and the soil is provided chiefly for the purpose of supplying moisture to the roots.

Necessity of good roots.— In forcing, practically all of the food used by the growing stalks comes from the supply already stored in the roots before planting in the forcing bed. For this reason, good, large, well-fed roots, at least two or three years old should be selected for forcing. These may be taken from the frozen ground and placed in the forcing bed, or dug in the fall and allowed to freeze in open sheds or in the field where coats of straw or leaves are put over them to prevent alternate freezing and thawing. Roots do not need to be in a frozen condition when planted in the forcing bed, but previous freezing is necessary for the production of good yields.

The forcing bed.— The roots may be packed closely together in the forcing bed and the soil should be packed under and between the clumps of roots so that the crowns are about level with the surface. Growth will begin as soon as the proper conditions of heat and moisture are supplied. The temperature may range from 40° to 75° but the rapidity of growth of the stalks is almost directly proportional to the heat supplied. Hence, the ripening of the crop can be hastened or retarded, to a considerable extent, by regulating the temperature. On the average it requires about five weeks to mature a crop from the time of planting in the forcing bed. The lower temperatures and slower growth give a better product and greater yields, 50° to 60° being most generally recommended.

The effect of forcing on the roots.— Forcing is naturally a heavy drain on the roots and if they are to be used at all for resetting they should be removed from the forcing bed upon the first signs of slackening in growth. If given proper care the roots will regain their vigor in the plantation in two or three seasons. A new supply of roots should be used for forcing the next season. In order to secure a succession of forced rhubarb, roots must be brought into the warm cellar at intervals of three to four weeks.

Quality of forced rhubarb.— Rhubarb forced in the dark has a very attractive appearance, the stalks being a bright crimson color while the leaf blades never fully develop in size and remain a bright yellow. The crop is harvested and handled the same as the outdoor crop except that in preparing for market the lower portion of the blanched leaf blade is left on the stalk as an attractive feature. The quality of forced rhubarb is very good, the stalks being very tender and of a flavor slightly less tart than normal growth. Because of the simplicity of the process and the value of the product it is recommended that forcing rhubarb be given more attention.

Varieties.—**Linnaeus.**— The standard early variety. Stalks rather small but of good bright color. Skin thin and tender, good quality. A profitable kind for the earliest markets but too small to compete with the larger varieties later in the season.

Victoria.— The standard midseason variety. About a week later than Linnaeus. Stalks large, bright clear red, crisp, tender, juicy and fine flavored. Good for market or home use and a favorite with canners.

Mammoth Red.— A later variety and a rank grower. Stalks numerous, short, thick, deep red. Not as fine in texture or flavor as the smaller sorts but attractive in appearance and a good yielder. Preferred by many growers for forcing.

HOT AND COLD FRAMES.*

J. W. WELLINGTON.

Origin.— Undoubtedly the use of glass as a factor in vegetable production had its beginning in a desire to protect young plants from late spring frosts. Probably at first the frames were crudely made and covered with ordinary house windows. From such an humble start has been evolved the elaborate greenhouse; nevertheless the simple frame in its perfected state has a permanent place in the vegetable industry.

Hot bed and cold frame.— These terms are often used together to the confusion of the beginner. The only essential difference, however, is that one is provided with heating material beneath the soil in the shape of fermenting horse manure or warmed pipes while the other has only the natural heat of the sun. Cold frames are often built of lighter material and with less care, in that their function is generally that of protecting, and not starting, young plants. Hot beds on the other hand are built for the purpose of conserving heat during the cold nights of early spring and are built strongly and carefully.

Location.— In planning frames for vegetable work, the builder should select as sunny an exposure as possible, bearing in mind, nevertheless, proximity to buildings and to water supply. Very often the south side of a building may be used advantageously, thus affording at once protection and proper exposure. Commercial growers often erect a tight board fence six to eight feet high to shut out the cold north and northwest winds, as experience has proved the necessity and value of such protection. The fence boards are often used for blanching celery. The situation selected must be well drained so that no water can stand about the frames. The character of the soil is of no importance in that earth is generally supplied from a compost heap or other sources.

Commercial frames.— Frames are offered for sale by certain firms but generally at a price which renders them too expensive for the ordinary gardener.

Home construction.— Frames built at home have the advantage of being built solidly, of better material and at a saving in initial cost. Two-inch plank is commonly used as material. Since the sash are six by three feet in dimension the frame should be built with an outside width of six feet and length whatever multiple of three feet is desired. Frames are constructed in parallel rows, leaving a walk between. With this plan, less protective fence is needed and less pipe and hose are required for watering. The frame may be built above ground and then lowered two or three inches into the soil or may be constructed in the excavation. The south or front edge of the frame should be four to six inches lower than the north or back, which variation is usually accomplished by using a twelve-inch plank in front and a sixteen or eighteen inch plank in rear. Although single planks are desirable, two narrow ones may be used, taking care to make as close a joint as possible. The end pieces must be sawed diagonally to accord with the front and back plank. Upon completion the frame should be leveled lengthwise and fastened firmly to posts. In long beds it will be necessary to insert cross braces of two-inch joist at every sixth or ninth foot. The slant provided by the difference in height of front and back edges carries away water and also places the glass at a more favorable angle to the sun's rays. At the time the growing plants reach the glass, a superstructure of inch material may be provided for raising the sash to the desired height.

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* A reprint of Circular No. 35, January 25, 1915.

Frames are sometimes constructed of brick or concrete, but although of greater durability are not equal to wooden frames in plant production in that they are often too damp and cold.

Sash.— The windows used for covering frames are commonly known as sash or glass. They are built expressly for garden purposes and are usually built with extra workmanship and of extra good material. Cypress lumber is quite generally used because of its greater durability. Exposure in a horizontal position to all sorts of weather, together with the strain of constant handling, soon ruins cheap and inferior sash. The prospective purchaser should reduce the number rather than the quality of his windows. Sash may be obtained with or without glass; in the second case less danger is incurred in transit. The price of glass is fluctuating and hence the grower should watch the market carefully. The large buyer may better deal with the manufacturer, the purchaser of one or two sash with his local hardware dealer.

Protection.— Straw mats or other covering must be provided for protecting the beds from the cold nights and inclement weather of early spring. Rye is the best mat material on account of greater length and flexibility of stalk. These mats are a common article of trade and may be purchased from most seed houses. Many gardeners weave their own, either growing the rye or purchasing it from some one who has grown it for the special purpose in that the crop should be cut while yet green and cured with particular care. Mats are generally six by six feet in dimension, sufficient size to cover two sash. Their endurance is limited to a few seasons and care should be taken to handle carefully, storing them in a dry place in idle season.

For very early crops it is often advisable to have wooden shutters of dimension six by three feet to lay over the mats. Snow and ice are thereby more easily removed and the lifetime of the mat prolonged. The shutters assist in keeping the beds warm.

Winter care.— Frames should be built in the fall before ground freezes. The soil should be dug out from within the frame to a depth of two feet or more, being careful to cut the sides as squarely as possible. The empty pit thus formed may be filled with leaves or strawy waste and the wooden shutters laid over and nailed lightly so as to prevent their blowing away. This late fall care will save a lot of hard labor in the spring in digging out frozen earth. During the winter the sash should be overhauled, broken glass replaced and a coat of good paint applied when needed.

Manures.— Manure is the life of the hot bed and the preparation thereof is a matter of great importance. Many failures may be traced to this point. Horse manure composed of part litter is best, such as may be obtained from private stables where the horses are well fed and where care is exercised in shaking out the bedding. Work should begin at least a fortnight ahead of actually making the bed. The manure should be piled in a compact heap in a cellar or shed and if very dry should be watered slightly but not drenched. After heating begins in earnest the pile should be reworked, endeavoring to break up lumps and to make a uniform mixture. The manure should be put into the pit as soon as the pile is in a steaming condition. It should be forked in and carefully treaded or pounded, especially in corners of the frame. The pit should be filled in this manner level with the ground surface. The beginner may feel as though he is using too much manure but poor preparation will result in poor results. The frame may be banked to retain heat.

A hotbed may be made all above ground by placing a frame upon a compact leveled pile of manure. A bed of this sort, however, is not adapted to our cold spring days.

Soil.— The soil may be put in the bed directly after manuring, but no seed should be sown or plants set until after the manure has heated once and cooled to such a degree that the soil is warm but not hot to the hand. This point may be better determined by a thermometer thrust in the soil, which should register about 90°. Two or more days may pass before conditions warrant planting. The soil for sowing seed should be quite sandy and new soil or sterilized soil will insure better results. Soil for setting little plants should be from a compost heap or from a fertile source. Four inches of earth will suffice for seeding, thus leaving six to eight inches between soil and glass. Care should be used not to put on too much soil lest the heat may not be able to rise rapidly enough to the surface.

Planting.— Vegetable seed may be broadcasted or sown in close rows and covered by sifting on a little soil. The broadcasting method is more rapid and with moderate sowings is as good. Seedlings are transplanted while yet very small, and, therefore, have little opportunity to crowd one another. These little plants are generally reset when the first true leaf appears and should be given at this time plenty of space to develop into sturdy individuals. Certain crops, as radish, beet, carrots, are not moved and should be sown in rows the full distance apart and thinned in the row. Papers laid upon the soil will hasten the germination of seed but must be removed just as soon as the plants appear.

Protection.— The grower must practice every care to conserve the vital heat of the bed. The mats should not be removed in the morning until the sun is well up and should be replaced as soon as the rays have lost their heating powers. On exceptionally stormy days the mats may be left on all day. Nevertheless the grower should give the plants light whenever compatible with their safety.

Water.— The soil in which the seeds are sown should be moist but not wet. The water present at sowing is usually sufficient to raise the plantlets to moving age. If the top soil becomes dry it should be watered with lukewarm water. A watering can with rosette is ideal for a few sash. A water system should be installed for commercial gardens so that a hose may reach any part. Benefit will result from warming the water to about 60° but this is not always practicable. Drenching is not desirable at early stages, but light, frequent waterings. A bright sunny morning is a favorable time.

Ventilation.— Air must be supplied to the growing plants whenever the day is warm enough to allow raising the sash. This dries out the beds and helps to control disease and to promote sturdy growth. In early spring the windows may be raised very slightly on sunny days—perhaps for an hour or two at noon. The strengthening sun will enable the grower to give more air and indeed he must watch this point carefully as one neglect to cool the beds may easily spell ruin. The desideratum is to give the plants maximum light but not allow the temperature to run above their optimum point of welfare. The grower will soon learn to ascertain the approximate welfare point by placing his hand within the frame. By proper airing the plants may be kept strong; improper ventilation will result in long, leggy, weak plants of questionable value. Windows should be raised from the side and not from the end and in such manner that the prevailing wind will sweep over and not into the frames. A piece of board cut with notches of different heights is very serviceable for raising the windows. The value of ventilation depends on the grower; the sudden changes of cloud to sunshine and drops and rises in temperature are calls for personal judgment and not for rule.

Crops.—Lettuce, radish, parsley, carrots, beets and onions are among the vegetables which may be raised to maturity in the hot bed. Tomato, pepper, egg-plant, cucumber, melon, celery, cabbage and many other plants are given an early start which means success. Dandelions, spinach, rhubarb, asparagus and others are forced for early market in cold frames.

DAHLIAS AND THEIR CULTURE.*

F. H. HALL.

About a century and a quarter ago, a little Mexican flower, soon named " dahlia ", was first introduced to the gardeners of Europe. The blossoms then consisted merely of a few floral rays or " petals ",— red, yellow or purple in color — about a central disk of rayless, yellow florets. The flowers, near relatives of our common weed, the beggars' tick, and of coreopsis and cosmos, were only small to medium in size; but their lightness and grace, the purity and brilliance of their colors, their rapid changes under cultivation, and the freedom of bloom of the plants soon won them popularity.

From this " single " type, the dahlia has since passed through one of the most wonderful developments known in floriculture, well justifying the species name generally given to it, *variabilis;* and, today, it probably shows a greater diversity in habit, size, form and color, and is represented by more named varieties than any other species (or group of closely allied species) known to the florist. Among the multitude of flower-forms we have almost exact duplicates of cosmos, daisy, poinsettia, clematis, anemone, zinnia, aster, water lily, cactus, chrysanthemum and peony, with many other forms peculiar to the species itself. In size the blossoms range from tiny blooms an inch or less in diameter to huge flowers rivaling the sunflower; they show every color, tint and shade, except the blues, known among flowers, and every combination of these by suffusion or variegation,— in brilliance equalling geranium or salvia, in delicacy approaching roses or orchids, in range from a maroon almost reaching black to a white as pure as that of the Easter lily.

One fault, indeed, they have! They are practically odorless; though a few faintly scented varieties have arisen, and this characteristic, like others non-existent or at least hidden in early days of dahlia history, can probably be developed or intensified should popular favor demand it.

Simple in cultural demands, adapted to a wide range of soils and conditions, with plants so diverse in size and habit that one can readily be found appropriate for any situation, affording a wealth of bloom over a long season, suitable, in some of the many varieties, for every floral purpose,— for garden decoration, for bouquets and florists' work, and for wonderfully attractive display on the exhibitors' tables,— the dahlia now holds high rank as a late summer flower, and it certainly merits equally with the chrysanthemum the title " Queen of Autumn Flowers;" for the dahlia is as beautiful and as useful outdoors before frost as is the chrysanthemum inside a little later.

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* A reprint of Circular No. 43, November 30, 1915.

Yet so recent is the development of the dahlia in its most pleasing and most useful forms, that many flower lovers, particularly in the country, where the dahlia should be most popular, know nothing of the modern types. To such persons the idea conveyed by the name dahlia is that of stiffness and formality as shown by the ball-shaped blossoms of the " show " and " fancy " types once so popular. These are models of perfection in form, of symmetry and regularity, and are often of most exquisite coloring, but they lack the grace and artistic appeal that help to make flowers so attractive and that have been wonderfully developed in the newer dahlias.

What a surprise it is to many a flower lover to see for the first time a modern collection of dahlias! Its English singles, its pompons and its miniature cactus types are so bright and yet so dainty; its " Century " singles so large and striking but, withal, so graceful; its " decoratives," ranging from tiny to huge, are so perfect in form yet loosely built and pleasing; its " cactus " dahlias so refined and delicate of petal, like masses of interlaced, slender, curved tubes of ribbon with tints almost as varied and delicate as those of changeable silk; and its peony-flowered types so artistic in the informal, open arrangement of their long, curled, twisted petals and so gracefully held on long stems that raise them far above the bright green foliage.

The author and many of his friends and other visitors to the Station have been so pleased with these " new " dahlias as grown here that it seems a duty to prepare a little discussion of the flowers and the method of caring for them, with a selected list of varieties; so that others who would enjoy the beauties of a good dahlia collection may be guided in starting or extending one.

HISTORY OF THE DAHLIA.

The dahlia, as " Acocotli," was known to Europeans in Mexico probably two centuries before the plant reached Europe in 1789; for in 1615 Francisco Hernandez described and illustrated two forms of the flower in his book on the plants and animals of New Spain. Other Spaniards, who overran and conquered the country in the previous century, must have seen, before Hernandez' time, the bright red, purple and yellow single flowers of the different closely allied species we group in the genus Dahlia; for these flowers were undoubtedly abundant, then as now, in their native habitat, the Mexican highlands and mountain sides 5000 feet or more above the sea.

After Hernandez' mention of the flower we have only two known references to it in the century and three-quarters before it reached Europe. One of these was in a book by Vitalis Mascardi, published in Rome in 1657, whose description was based on that of Hernandez and whose figures are unsatisfactory. In 1787 Nicholas Thierry de Menonville, a French botanist who had been sent to Mexico to study the cochineal insect, reports that he saw the Acocotli growing in a garden in that country,— the first mention of the dahlia as a cultivated flower.

In 1789 Vincentes Cervantes, director of the Mexican Botanic Garden, sent seeds of Acocotli to the Abbe Cavanilles, director of the Royal Gardens at Madrid; and the Marchioness of Bute, wife of the English ambassador to Spain, sent a few of the seeds to England. Plants from these seeds lived only two or three years in England, but Abbe Cavanilles succeeded better with his seeds and within a year secured not only single but semi-double flowers from plants he grew. In 1791 he published a figure of this semi-double form in his *Icones et Descriptiones Plantarum*, naming it " Dahlia " after Mons. André Dahl, a noted Swedish botanist, and " pinnata " because of its pinnate, or winged, leaves. He later named two other forms *D. coccinea* and *D. rosea;* but *D. pinnata* was probably the ancestor of most of our cultivated dahlias, though some other wild species, of which there are a half-dozen or more in Mexico, Guatemala and elsewhere, may have contributed to the stock or have been used in dahlia breeding. In floricultural literature, however, the name *Dahlia variabilis* has most commonly been applied to the great collection of named varieties, but with a pronounced effort to set off a large section of them, recently developed, under the specific name of *D. Juarezii*, from the ancestor of this type. It is not definitely known, though, whether the original *D. Juarezii* was a true species originating in the wild, or a strongly marked cultural variation. Some English growers claim to have had, and discarded, similar flowers in their gardens.

Cavanilles sent seed of his three varieties to various botanical gardens in Europe,— to Berlin and Dresden before 1800, and to the Jardin des Plantes at Paris and to Montpellier about 1802. In Germany, dahlias were first called " Georginen," after Prof. Georgi; and the ball-shaped types are still frequently so named. About 1799 Humboldt and Bonpland the famous naturalists, found the dahlia growing wild in Mexico. They sent plants of it to the Botanic Garden in the City of Mexico, and from here some were sent in 1804 to the Jardin des Plantes, specimens being there found indentical with *D. coccinea* received from Cavanilles.

The first English publication to mention the dahlia is the *Botanical Magazine*, which, in 1804 gave a colored plate of *D. coccinea*, from plants raised by John Fraser of London. He had obtained the seeds from Paris two years before. In 1804 another lot of seeds reached England from Madrid, Lady Holland sending them to the librarian at Holland House, Kensington, and he grew successfully three varieties. Dahlias spread to other English gardens and here, as in Germany and France, the growers sought for double flowers and soon secured them. The earliest ones to attract general attention were produced by Herr Hartig at Karlsruhe and by Herr Haage at Leipzig, Germany, by M. Donkelaar at Louvain, Belgium, and M. Lelieur and Comte de Vandes of France. One of these double flowers sent to England by Comte de Vandes was illustrated in the *Botanical Magazine* for 1817, and shows a fully doubled, rose-colored blossom of flat shape.

In England this early flat, hemi-spherical flower, similar to our older decoratives, became wonderfully popular, but the type changed about 1840 to the more solid, ball-shaped blossoms of the show and fancy types. From 1820 to 1860 dahlia enthusiasm in England almost approached that of the earlier "tulip craze" of Holland; gardeners and amateur growers contested with thousands of blossoms in the many shows; and as high as £200 ($1000) was paid for promising novelties. The large, ball-shaped types reached perfection in many colors during the latter half of the period, as shown by good illustrations, notably those in Hogg's "The Dahlia" (1853). The flatter flowers of the previous score of years, however, were not to be compared in size or delicacy of color to the decoratives that came into renewed popularity about 1870, as the latter are inferior to those that French and a few American breeders are giving the dahlia world today.

During the latter part of the "show" dahlia period the small-flowered types of these quilled-petaled blossoms came to the front, originating probably in Germany, as Hartwig's double, of about 1808 was undoubtedly of small size. As "bouquet," "lilliputian" and "pompon" dahlias, these brilliant, small blossoms, borne so freely on long stems, superseded the heavier flowers in popular favor for a time, but the stiffness and formality of all these forms failed to hold the interest of flower-lovers generally, and for the decade from 1860 to 1870 the dahlia rapidly lost popularity in England.

A brief revival came with the advent of two new singles and the reintroduction of the old *D. coccinea,* all brilliant and graceful blossoms; and for a few years the gardens and shows were gay with these attractive, strikingly colored single flowers.

But the great advance in dahlia popularity, so far as the general public is concerned, came with the introduction from Mexico of what we now know as *D. Juarezii.* Among a miscellaneous lot of seeds, roots and tubers sent in 1872 by a friend in Mexico to M. J. T. Van der Berg of Holland, and received in bad condition because so long on the way, was one tuber which later produced a brilliant scarlet flower, of a shape hitherto unknown. It was a double flower, but open and light in build and with petals pointed and slightly rolled back at the margins. This was given standing as a botanical species and named in honor of President Juarez of Mexico; but from similarity in color, and some resemblance in form of this first flower to the "Showy Cactus" (*Cereus speciosissimus*), the widely variant descendants of this new Mexican introduction have all been called "cactus dahlias." The elegance of form, diversity of type and size and the wonderfully delicate colors, shades and tints of these cactus dahlias gave a new impulse to dahlia culture. In forty years since the first plant of the type appeared in Holland, two thousand or more named varieties showing its influence have been described, and scores of growers in England, France, Germany and America have given to dahlia lovers flowers as perfect in form as any of the old show types, with a lightness and grace that place them incomparably above those old favorites, and with a range of colors and color combinations greater than that of any other flower.

By crossing the cactus dahlias with singles, a still lighter, more artistic form has been developed (first in Holland about 1900), the peony-flowered dahlia, in which the tendency of the cactus type to weak stems and hiding among the foliage has been conquered; and we have graceful, open-centered, curled-petaled, large flowers of entrancing tints and shades, freely produced on upright plants and held firmly on good strong stems — suitable alike for the garden and for cutting. These now rival, if they do not exceed the cactus dahlias in popularity.

Recently, also, has come a revival of interest in single dahlias, with the introduction of large-flowered varieties of this type, in colors solid, shaded or tinted, beautifully suffused, and variegated, which add a new touch to garden decoration.

In France " decoratives " have lately reached their highest development; and some of the huge, flat, double flowers of this type receive as many votes in dahlia elections as cactus and peony-flowered varieties. France also contributed a strictly new type about 1899, the " collarette," in which single dahlias of various colors add to their beauty a row of inner small, slender petals of different color or tint, making a distinct fringe or collar between the broad outer rays and the central disk. Still another type is known abroad, but seldom seen in America, the " anemone-flowered " dahlia, in which the disk florets of single dahlias have developed small tubular petals, usually of different color from that of the ray florets.

We are unable to find any record of time, place or manner of the first introduction of the dahlia into the United States; but it undoubtedly took place not long after double dahlias first became known in England, and almost certainly from that country.

The first treatise on the dahlia known to have been published in America appeared in 1839, and its author, Sayers, says: " In this part of floriculture America keeps a closer pace with Europe than in the culture of any other class of florists' flowers "; and, also, that it is " Only within ten or twelve years that any fine specimens were to be seen." He lists 28 varieties then in general cultivation and 58 new ones; but an account of the 1835 show of the New York Horticultural Society gives the names of 30 exhibitors, one of whom showed 114 imported varieties. In the catalogue of Wm. Prince, Flushing, L. I., 1823, 41 varieties are listed; and the catalogue of G. Thorburn & Son, New York City, 1823, states that the dahlia is " of very late introduction into this country ".

The subsequent history of the flower in America has followed, in general, its course in England, with a period of great popularity for shows and fancies and a decline of that popularity about the middle of the last century and no marked revival of it until very late in the century, much after the renewal of interest in Europe by the introduction of *D. Juarezii*. By 1895 the dahlia was again receiving much attention and there has been a constant increase in popularity until today the flowers are very extensively grown. Several plantations of from 50 to 120 or more acres are to be found near the Atlantic seaboard, others, of hundreds of varieties, extend in an almost unbroken line of states to the Mississippi, a few lie in the eastern foothills of the Rocky Mountains and a large number again on the Pacific slope. Small collections, some of them very choice, are grown in thousands of amateurs' gardens; and, yearly, increasing numbers of scattered plants are seen in dooryards, lawn borders and plant beds near city, village, and rural homes.

CLASSIFICATION OF DAHLIAS.

As indicated in the history of the dahlia, we now have many classes of the flower. These classes and the definitions of them recently adopted by the American Dahlia Society are as follows:

1. CACTUS DAHLIAS.

a. True, fluted type: Flowers fully double; floral rays (petals) long, narrow, incurved or twisted, with sharp, divided, or fluted points and with revolute (rolled back) margins, forming, in the outer florets, a more or less perfect tube for more than half the length of the ray.

Typical examples: Snowdon, T. G. Baker, Mrs. Douglas Fleming, J. H. Jackson, H. H. Thomas and Rev. T. W. Jamieson.

b. Hybrid cactus or semi-cactus type: Flowers fully double; floral rays short as compared with previous type, broad, flat, recurved or twisted, not sharply pointed except when tips are divided (staghorn), margins only slightly revolute, and tubes of outer florets, if any, less than half the length of the ray.

Typical examples: Master Carl, Perle de Lyon, Flora, Mrs. J. P. Mace, Kalif and Rheinkonig.

2. DECORATIVE DAHLIAS.

Double flowers, full to center in early season, flat rather than ball-shaped, with broad, flat, somewhat loosely arranged floral rays with broad points or rounded tips which are straight or decurved (turned down or back), not incurved, and with margins revolute if rolled at all.

Includes forms like those of Souvenir de Gustav Douzon, Jeanne Charmet, Le Grand Manitou, Delice, Lyndhurst and Bertha Von Suttner; but *does not* include Le Colosse, Mrs. Roosevelt, Dreer's White, Grand Duke Alexis or similar forms, which fall into section B of the ball-shaped double dahlias.

3. BALL-SHAPED, DOUBLE DAHLIAS.

A. Show type: Double flowers, globular or ball-shaped rather than broad or flat, full to center, showing regular spiral arrangement of florets; floral rays more or less quilled or with markedly involute margins and rounded tips.

(The class called Fancy Dahlias is not recognized separately in this classification, but is included in the sub-section A.)

Typical examples of Show Dahlias: Arabella, Dorothy Peacock, Gold Medal, John Walker, Colonist and A. D. Livoni.

B. Hybrid show, giant show or colossal type: Flowers fully double, broadly hemispherical to flatly globular in form, loosely built so spiral arrangement of florets is not immediately evident; floral rays broad, heavy, cupped or quilled, with rounded tips and involute margins.

Typical examples: Grand Duke Alexis, Cuban Giant, Mrs. Roosevelt, Le Colosse, W. W. Rawson and Golden West.

C. Pompon Type: Shape and color may be same as A. or B.; but must be under two inches in diameter.

Includes forms like those of Fairy Queen, Belle of Springfield, Darkest of All, Nerissa, Little Herman, and Snowclad.

4. PEONY-FLOWERED OR "ART" DAHLIAS.

Semi-double flowers with open center, the inner floral rays being usually curled or twisted, the other or outer petals being either flat or more or less irregular.

Typical examples: Queen Wilhelmina, Geisha, Hampton Court, Mrs. W. Kerr, P. W. Janssen, and Glory of Baarn.

5. DUPLEX DAHLIAS.

Semi-double flowers, with center always exposed on opening of bud, with petals in more than one row, more than 12, long and flat, or broad and rounded, not noticeably twisted or curled. (Many so-called Peony-flowered Dahlias belong here.)

Typical examples: Big Chief, Souvenir de Frans Lisst, Merry Widow, Sensation, Prairie Fire and Hortulanus Budde.

6. SINGLE DAHLIAS.

Open centered flowers, small to very large, with eight to twelve floral rays more or less in one circle, margins often decurved (turned down or back). There are no distinctions as to colors. The type embraces the large Twentieth Century,—as well as small English varieties.

Typical examples: White Century, Golden Century, Scarlet Century, Newport Marvel, (of the large flowered forms); with Polly Eccles, Leslie Seale, Danish Cross and Ami Barillet, (of the lesser flowered forms).

The Star singles and Cactus singles are omitted from the present classification scheme as not being sufficiently numerous or well defined yet.

7. COLLARETTE DAHLIAS.

Single type: Open centered blossoms with not more than nine floral rays with one or more smaller rays, usually of a different color, from heart of each ray floret, making a collar about the disk.

Typical examples: Maurice Rivoire, Souvenir de Chabanne, Diadem, Orphee, Madame Poirier and Albert Maumenee.

8. ANEMONE-FLOWERED DAHLIAS.

Flowers with one row of large floral rays like single dahlias, but with each disk flower producing small, tubular petals.

Includes such forms as those of Grasiella, Mme. Chas. Molin, Claude Barnard and Mme. Pierre Dupont.

9. OTHER SECTIONS.

Miniature or Pompon Cactus. Small flowered, stellate, fine-petalled cactus dahlias represented by Tom-tit, Mary, Nora, Minima. *Mignon or Tom Thumb.* — Dwarf bushy single flowered Dahlias for edging. Typical examples: Jules Closson. *Bedding Dahlia.*— A taller, more upright type than the Tom Thumb. Typical examples: Barlow's Bedder and Midget Improved. *Cockade or zonal Dahlias.*—Single or collarette Dahlias, with three distinct bands of color about center. Type hardly known in America, but includes such forms as that of Cocarde Espagnole.

THE "BEST DAHLIAS"

In an effort to secure confirmation of his own judgment in selecting dahlia varieties worthy of recommendation for general culture, and to include the better ones among varieties unknown to him, the author prepared and sent to about forty leading American dahlia growers and specialists a blank form for a list of dahlias that should include the best in each kind and class. Twenty-five of these forms were returned, filled out wholly or in part; and the information thus secured is the basis of the list given below. The lists have been supplemented by nearly ten years' personal experience with dahlias, during which more than one thousand varieties have been grown, by visits to the fields of a dozen or more growers of dahlias on an extensive scale (over 300 acres in all), by preparation of a card catalogue of three thousand of the older varieties, and by study of recent growers' catalogues that describe half as many more new varieties. It is believed that no variety has been here listed that is not worthy of a place in any collection, and it is hoped that no variety of superior merit, grown long enough or widely enough in America to demand consideration, has been omitted. It has not been possible to select the "best" only; since this would require careful, scientific and impartial study, extending over several seasons, of all the varieties here listed, and many others, collected in one place. Such a study is greatly needed, and it should be the desire and aim of all dahlia lovers to secure, through a National Dahlia Society or some other agency, some plan of cooperation whereby order can be brought out of the present chaos of dahlia varieties.

In consulting the following lists these points should be borne in mind: Lack of space prevents detailed descriptions of varieties, but these have been grouped as carefully as possible (considering the widely variant ideas of color and type now existing) by class and by color. Following the name of a color group in each class of dahlias, the names are first given, sometimes in two sections, of those varieties selected by more than two authorities as "best" of the type and color; and, second, when thought desirable, the names of new or less known varieties that are believed to be of superior merit, but that have not been extensively tested. Names marked with a star (*) are those of varieties grown or studied by the author, whose judgment supports that of others in listing these varieties; those not so marked are included on the recommendations of others only, the writer not having seen the varieties. A few names are printed in **bold face** to indicate varieties so widely grown or of such splendid quality that they occupy preeminent places in the dahlia realm.

SINGLE DAHLIAS.

Singles are not especially popular in America today and the varieties grown are not, in the main, widely distributed. For this reason, it is quite difficult to select varieties that stand out above their fellows, since only limited numbers of growers agree in their choices.

Singles of the old, small or English type make up the first alphabetically arranged group after each color name; those of the new, large, or Century type, the second group.

White — Alba Superba*, Rebecca Mayhew, Snowdrop; — Gigantea Alba*, The Bride*, White Century*. New — Rhode Island*, White Cloud, White Elephant, White Shower.
Blush and light pink — Mary; — Anna Long*, Margaret Perkins, Newport Cheer*. New — Newport Pink*.
Pink and rose — Betty*, Columbine, Princess of Wales; — Imperialiana*, Mrs J. C. Hance*, Rose-pink Century*. New — Lady Bountiful*; Gladys.
Deep pink to pure red.— (*including combinations of white and crimson*) Mrs. J. G. Randall, Prosperity; — Fringed 20th Century*, Newport Beauty*, Twentieth Century*.
Scarlet — Ensign, Miss Morland, Rosebank, Wildfire*; — Gorgeous*, Red Face*, Scarlet Century*, Wildfire Century. New — Newport Star*, Scarlet Shower.
Crimson and carmine — Ami Barillet*, Formosa; — Crimson Century, Hasel Heiter*, New — Crimson Shower, Newport Queen*.
Maroon — Blackbird*, Man Friday; — Belmont, Majesty, Maroon Century*, Dr. Hexamer*.
Cream and light yellow — Miss Roberts, New — Cream Century, Lemon Shower, Newport Yellow*.
Bright and deep yellow — Blanche*, Mildred*, St. George*; — Golden Century*, Newport Pride*. New — Golden Shower.
Orange — Morning Glow.
Buff, amber, pale orange, bronze, terra cotta, etc. — Amy; — Miss Edna Sharpe, Newport Marvel*. New — Mrs. Joynson Hicks.
Salmon, old rose, etc. — Eclipse; — Sunset.
Lavender, lilac, mauve and violet — Leslie Seale; Twilight; — Miss Barton, Weston.
Magenta and plum color — Mrs. Bowman; — Newport Charmer*, Radiance.
Purple — Serita, Utopian. New — Beauty's Mask*, Newport Glory*.
Bi-colored: White and red — Danish Cross*, Lucifer*, Magnificent, Paul; — Eckford Century*, Iris Century*, Old Glory.
Bi-colored: White and yellow — Hilda.
Bi-colored: Yellow and red — Cardinal, Fugi San*, Gaillardia*, Polly Eccles*, Mikado*. Peggy; — Elinor, Flaming Century, Jack*, Spanish Century.
Bi-colored: Miscellaneous — Kitty, Sadie*, Praxiteles*, Striking; — Dauntless.

DUPLEX DAHLIAS.

White — Frau Dr. Nebelthau*, Hathorne, Mme. Heriot. New — White Star.
Pink — Rubens. New — Crawley Star*.
Scarlet — Centaure, Merry Widow*.
Maroon — Big Chief*.
White and red — Ruskin*, Sensation*, Souvenir de Frans Lisst*. New — Krasy Kats, Loveliness.

ANEMONE-FLOWERED DAHLIAS.

Creamy white — Mme. Charles Molin.
Rose and yellow — Graziella, Luciana.
Red and yellow — Falstaff, Horace, Mars.
Brown and yellow, striped — Claude Barnard.
Maroon and purple — Le Styx, Mme. Pierre Dupont.

COLLARETTE DAHLIAS.

White, pink, red and scarlet: With white collars — Albert Maumenee, Comtesse Ici Hardegg, Diadem*, Directeur Rene Gerard*, Regularity. *With yellow collars* — Cocarde Espagnole*, Gallia*, Henri Farman*. *Crimson, carmine, purple and maroon: With white collars* — Capella, Mme. E. Poirier*, Maurice Rivoire*, Pres. Viger. *With yellow collars* — Comte Nodler*, Exposition de Lyon*, Frogmore. *Yellow, with white or yellow collars* — Buttercup, Goldstern.
Other color combinations — Mme. Capron*, Meteor, Souvenir de Chabanne*. *New* — Champion, Geante de Lyon, Jumbo, Marvel, The Sultan, White Prize.

POMPON DAHLIAS.

White and light pink — Daybreak*, Rosebud, Snowclad*, Star of the East, White Aster (Guiding Star).
Deep pink and light crimson — Marguerite, Nerissa*, Sunbeam.
Red and scarlet — Bacchus, Mars*, Red Indian, Sunshine, Vivid.
Dark crimson and maroon — Darkest of All*, Darkness, Raphael.
Cream and light yellow — Annie Doncaster, Canary, Little Bessie, Mary Keith, Sensation.
Deep yellow and orange — Bijou*, Catherine*, Ideal, Klein Domitea, Little May*, Myra.
Lavender, lilac, etc.— Adelaide, Alewine* Dewdrop, Pure Love.
Salmon, old rose, etc.— Gruss am Wein, Iris, Nellie Broomhead.
Magenta and purple — Bobby, Prince Charming.
Bi-colored: White and red — Brunette, Hedwig Pollwig, Little Herman*, Little Prince, Montague Wooten, Tommy Keith, *White and yellow* — Elfin*, Jewel (new), Leila, Zoe. *Yellow and red* — Hesperia, Jessica, Little Beeswing (new).

SHOW AND FANCY DAHLIAS.

No attempt has been made to maintain the purely artificial distinctions between these two classes. However, all the "Fancy" dahlias selected will be found in the various "Bi-colored" groups; though others in these groups are not strictly "Fancies." The letters c, e, g, preceding a name indicate respectively whether a variety is most suitable for cutting, garden decoration, or exhibition. It should be said, however, that very few varieties are really adapted to commercial cutting for shipment.

White — e Diamant*, ceg Dreer's White*, cg Ethel Maule*, ceg Gov. Guild, cg John Walker*, eg Mme. Heine Furtado*, c Mme. Henrietta Scalabre*, e Mme. Marika Anagnostiki*, c Miss Minnie Vosburg*, cg Storm King*, White Swan.
Blush and light pink — eg Caleb Powers*, Dorothy Peacock*, eg Grand Duke Alexis*, eg La Republique, cg Queen of the Belgians, e Mrs. Gladstone, ceg Susan*, New — Halcyon, Souvenir de ma Soeur.
Rose pink to rose color — ceg A. D. Livoni*, ce John Thorpe*, ceg Rose*, eg Souvenir de Mme. Moreau*.
Deep pink to pure red — g David Warfield, g Flachard, eg Le Colosse*, eg Meteor*, e Paul David.
Scarlet — ceg Isis, ceg John Wyatt, ceg Merlin, e Paul Bert*, cg Red Hussar*, ceg W. H. Williams, eg Warrior. New — Globe de Mantes, Mme. Ant. Wauters, Miss Helen Hollis.

Crimson and carmine — ceg Bon Ton*, c Crimson Giant, cg Cuban Giant* (or Dr. J. P. Kirkland), cg Edward Mawley, e Emperor.

Maroon — cg Black Diamond*, e Black Dude, ceg Mr. Chamberlain, ceg Sir Richard Wallace*, cg Thos. White*, eg Victor.

Cream and light yellow — ceg Arabella*, ceg Esmond, e Mrs. Glascock*, ceg Tom Jones.

Bright and deep yellow — cg Mary D. Hallock*, (or Queen Victoria), cg Princess Victoria*, cg Queen of the Yellows*, eg R. T. Rawlins, Yellow Duke*. New — Estelle Christy, Mary Garden.

Orange — ceg Champion Rollo, eg Elberton, e John Bennett*, g Leander*, Nugget*.

Buff, amber, bronze, pale orange, terra cotta, etc. — ceg Chas. Lanier*, eg Dr. Keynes*, ceg Eugene Mezard* ceg Geo. Ade, Gracchus*, g Robin Adair*.

Salmon, old rose, etc. — g David Johnson*, ceg Grand Duchess Marie*, ceg Mrs. Dexter*, cg Sunburst*.

Lavender, lilac, mauve and violet — ceg Acquisition*, eg Chieftain, ceg W. W. Rawson*. New — Maude Adams*, Vivian*.

Magenta — g Electric, Souv. de Mme. Gagne*. New — Ansonia*, Limington.

Purple — ceg Gloire de Paris*, e Prince Bismarck*, c Stradella*, T. W. Girdlestone.

Bi-colored: Red and white — Annie Moore, Ethel Schmidt*, Gen. Saussier, Keystone, Lottie Eckford*, Mrs. N. Halls*, Mrs. Reg. Green, Souvenir, Striped Banner.

Bi-colored: White and yellow — Miss Browning*, Mrs. Saunders*.

Bi-colored: Yellow and red — Dazzler*, Duchess of Albany*, Gold Metal*, Kaiser Wilhelm*, Lucy Faucett*, Sunset, Wm. Pemberton.

Bi-colored: Purple or maroon and white or pink — Frank Goodman, Frank Smith*, Peacock*.

Other color combinations — Gen. Grant, Gen. Miles*, Prof. Faucett.

DECORATIVE DAHLIAS

White — eg Blanche Charmet*, c Corona*, Henry Patrick*, cg Kaiserin Augusta Victoria*, ceg Mme. Marze*, e Mlle. Helene Charvet, c Mrs. Winters*, ceg Mont Blanc*, ce Perle de Lyon*, Perle du Parc de la Tete d'Or, ceg Princess Juliana*, ce White Wings. New — Altadena, Hortulanus Witte*, Mrs. Henrietta W. Struck.

Blush and light pink — g Loveliness, ceg Mme. Van den Dael*, ce Mrs. J. G. Cassatt, Mrs. Roosevelt*, Sylvia*, Ville de Lyon. New — Eventide, Mrs. Thos. W. Barlow.

Rose pink to rose color — eg A. E. Johnson*, ceg Delice*, ceg Jeanne Charmet*, ceg La France*, cg Princess Victoria Louise*. New — Duc de Köstritz, Flamingo*, ceg Jean Wood*, Mrs. Frances King, Mrs. Jennie Walker.

Deep pink to pure red — eg Boisduval*, ceg Jack Rose*, g Mrs. Fleers, e Victor Velvet.

Scarlet — ceg Auguste Nonin*, cg Easton*, eg Fireburst, cg Lyndhurst, cg Wm. Agnew. New — e Breeze Lawn*, Manzanola, ceg Minnie Burgle*.

Crimson and carmine — c Catherine Duer*, e Le Geant*, ceg Papa Charmet*, ceg Paul David, eg Riese von Stuttgart. New — American Beauty*, Mrs. A. I. Dupont*.

Maroon — g Black Beauty*, cg Black Prince, ceg D. M. Moore*, ce Jumbo, ceg Ouray*, cg Ulysse*.

Cream and light yellow — e Gigantea*, Mme Victor Vassier*, eg Mrs. Chas. A. Turner*. New — Albert Manda*.

Bright and deep yellow — eg Brentwood, ce C. W. Bruton*, ceg Golden West*, ceg Yellow Colosse*.

Scarlet orange and orange — *ce* Chieftain, g Mme. Marie Collet*, *c* Orange Glare of the Garden, ceg Orange King*, ceg Sebastopol*, çeg Souvenir de Gustav Douzon. New — ceg Edna L. Hathaway*.

Buff, amber, pale orange, bronze, terra cotta, etc. — c Crown of Gold*, eg Kupferberg Gold*, eg Lucero*, eg Manitou*, cg Miss Minnie McCullough*, ceg Santa Cruz*.

Salmon, old rose, etc.— cg J. M. Goodrich*, cg John R. Baldwin*, ceg Mme. Louis Tillier, cg Phenomene, e Salmon Queen*. New — Hortulanus Viet*.

Lavender, lilac, mauve and violet — ceg Blue Oban*, ce Esmeralda, e Mme. Auguste Nonin*, ceg Mme. Aymard, cg Mlle. Marie Hoste,* ceg Maman Rozain*. New — Mrs. Wm. R. Warner, Jr.

Magenta — g Miss Barry, c Pendent*. New — Souvenir de Mme. Blonin.

Purple — cg Claribel*, ceg Commandant Rivoire*, cg Frank L. Bassett*, ceg Giant (or Royal) Purple*, c Gloire de Paris. New — J. K. Alexander.

Bi-colored: White or pink and red — ceg Beaute Lyonnaise, c Gaiety*, e Gov. Floyd*, ceg Le Grand Manitou*, ceg Mme. A. Lumiere*, ceg Mme. L. Perrier*, ceg Maid of Kent*, cg Mlle. Laurence Chabanne, ceg Progress*.

Bi-colored: Yellow and red — ceg Gloire Lyonnaise, ceg Mme. Vercruyssen, Prof. Mansfield*.

Bi-colored: Purple or maroon and white — e Morocco*, ceg Orra Dow.

PEONY-FLOWERED DAHLIAS

White — c Feldberg*, ce Mrs. T. G. Baker*, ceg Queen Wilhelmina*, cg Riesen Edelweiss*, cg Sneeuwwitje (Snow Queen)*, ceg South Pole*. New — Lady Muriel Paget*, Mrs. H. E. Fiske, Mrs. Jas. Grosvenor, White Lady.

Blush to light pink — ceg Gloire de Baarn* (Ruhm von Baarn), ceg Miss Gladys Dawson*, g Queen Emma*, Turner. New — Queen Esther, St. Louis, The Pink Lady.

Rose pink to rose color — ceg Hampton Court*, eg Ladysmith*, c Miss G. Keeling, ceg Weber*. New — John Wanamaker, Rose Queen, Sunrise.

Scarlet — eg Germania, ceg Liberty*, ceg Mme. Curtelin, ceg Mrs. J. B. Riding, cg Rheingau*.

Crimson and carmine — ceg Antoine Rivoire, ceg Duke Henry*.

Maroon — ceg Dr. Peary*, cg Dormouse*, c Garabaldi, g Holman Hunt.

Cream and light yellow — ceg Caecilia*, ce Caesar*, cg King Leopold*, cg Mrs. Geo. Gordon, ceg Queen Alexandra, e Queen Augusta Victoria*. New — Cream King, Osceola, Yellow Gem*.

Bright and deep yellow — eg Canary Bird, Mondscheibe. New — Convention Yellow*, ceg Dr. H. H. Rusby*, Miss Ruth Thurston*.

Orange — ce Eleanor Woodrow, ceg Hugo de Vries, g Lady Saville*, Themse*. New — Chatenay*, Tango Girl.

Buff, amber, pale orange, bronze, old gold, etc.— eg Col. Cody, g Frau Anna Galster, Frau Geheimrat Scheiff*, ceg Glory of Groenekan*, ceg Goddess of Fame, ceg Mannheim. New — Duchess of Brunswick, Miantonomi.

Salmon, old rose, etc.— Andrew Carnegie*, ceg Bertha von Suttner*, Lady Norman*, Liberty* (as flower ages), P. W. Janssen. New — America, Jean Anderson, Van Dyke*.

Lavender, lilac, mauve and violet — ceg Great Britain*, ceg H. J. Lovink*, ceg La Riante*, Mrs. Alfred Platt. New — Fraulein Budde, Miss Violet Beamish, Mrs. W. E. Whineray.

Magenta — c Col. J. St. G. Wolseley.

Purple — ceg Czar Ferdinand, ceg King Edward*, c The Warrior. New — Chicago, Glory of Nijkerk.

Bi-colored: White or pink and red — ceg Fritzimann*, Mme. A. Coissard*, Mrs. C. L. Seybold*, Paul Kruger*, Porcupine*. New — Electa*, Mrs. D. C. Blair, Pennant.

Bi-colored: White and yellow — cg Fraicheur du Matin*, ceg Kakudu*, Lord Milner. New — Empress, Garland, Virginia Marshall.

Bi-colored: Yellow and red — ceg Geisha*, ceg J. B. Heaton, g Mrs. Jacques Futrelle*. New — Fire Girl, La Lumiere*.

Other color combinations — ceg Duchesse Melzi d'Eril, Phenomenal*, Philadelphia*.

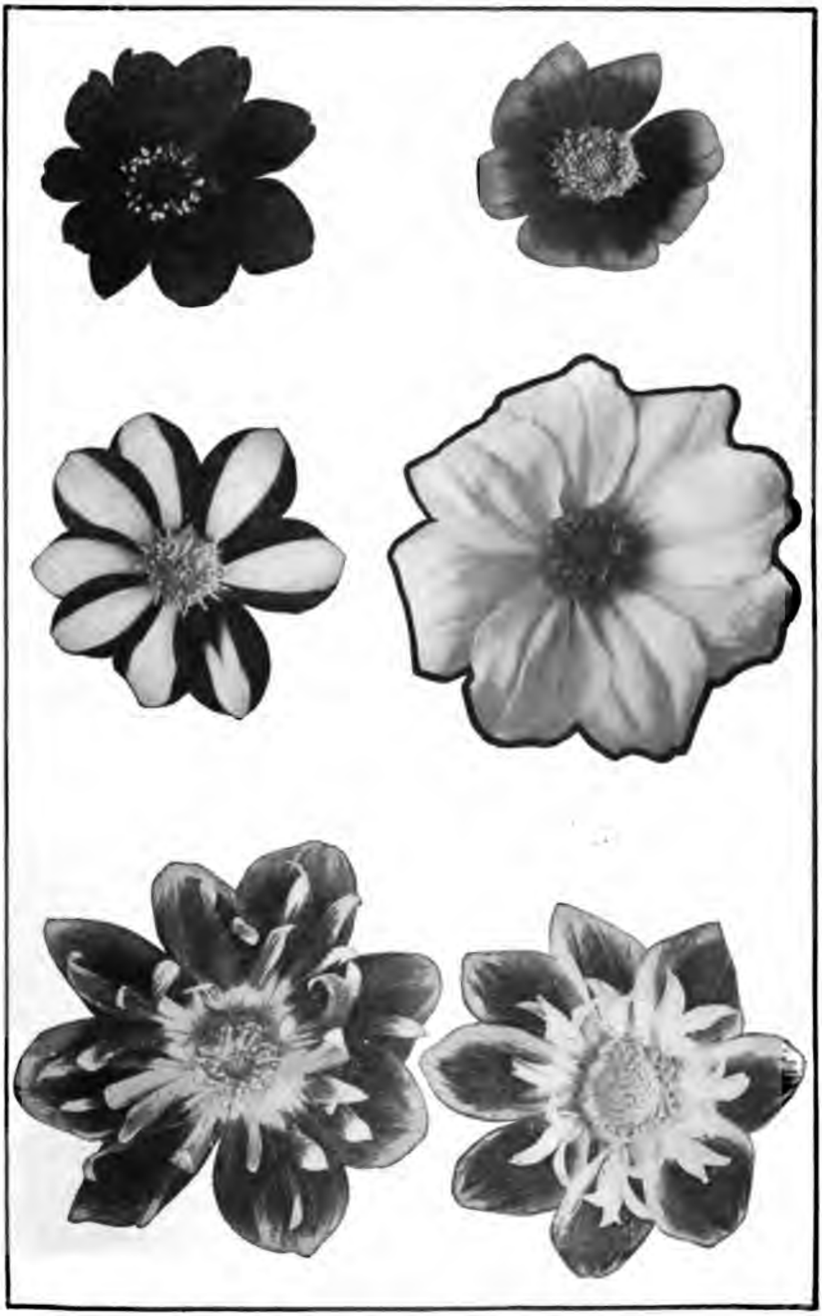

Plate XLVII.— Single and Collarette Dahlias.

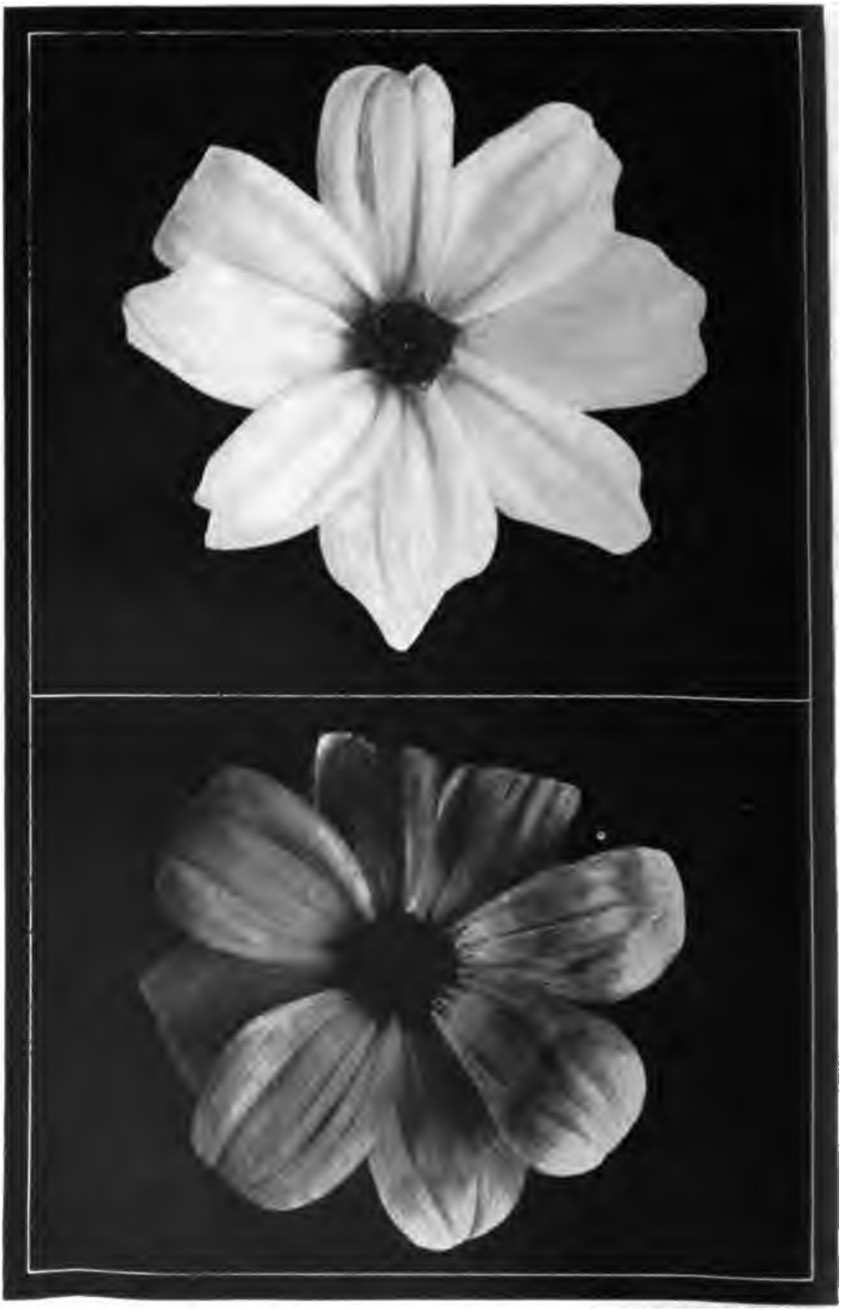

PLATE XLVIII.— SINGLE DAHLIAS OF "CENTURY" TYPE.

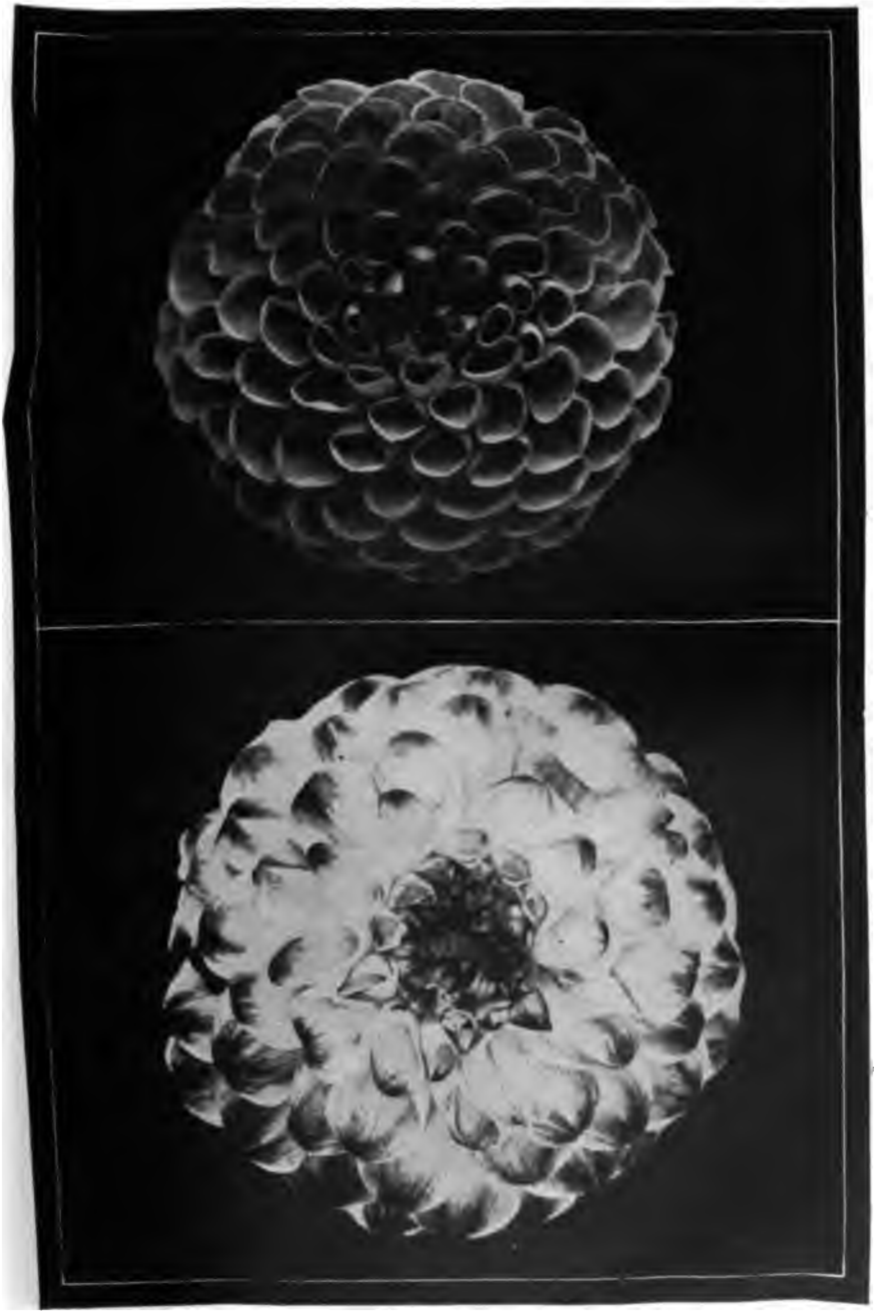

PLATE XLIX.— BALL-SHAPED DOUBLE DAHLIAS; "SHOW" TYPE.

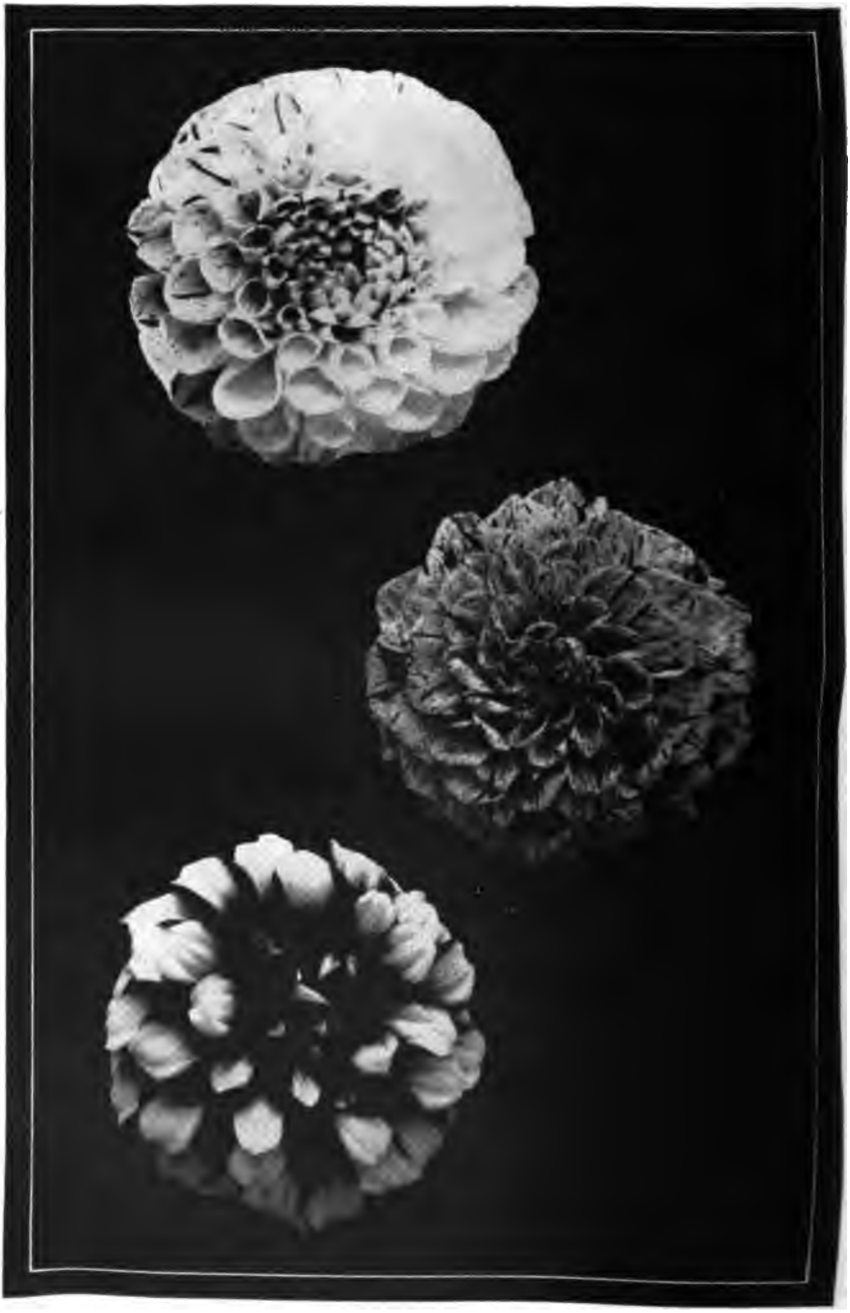

Plate L.— Ball-shaped Double Dahlias of "Fancy" Type; Variegated Decorative Dahlia

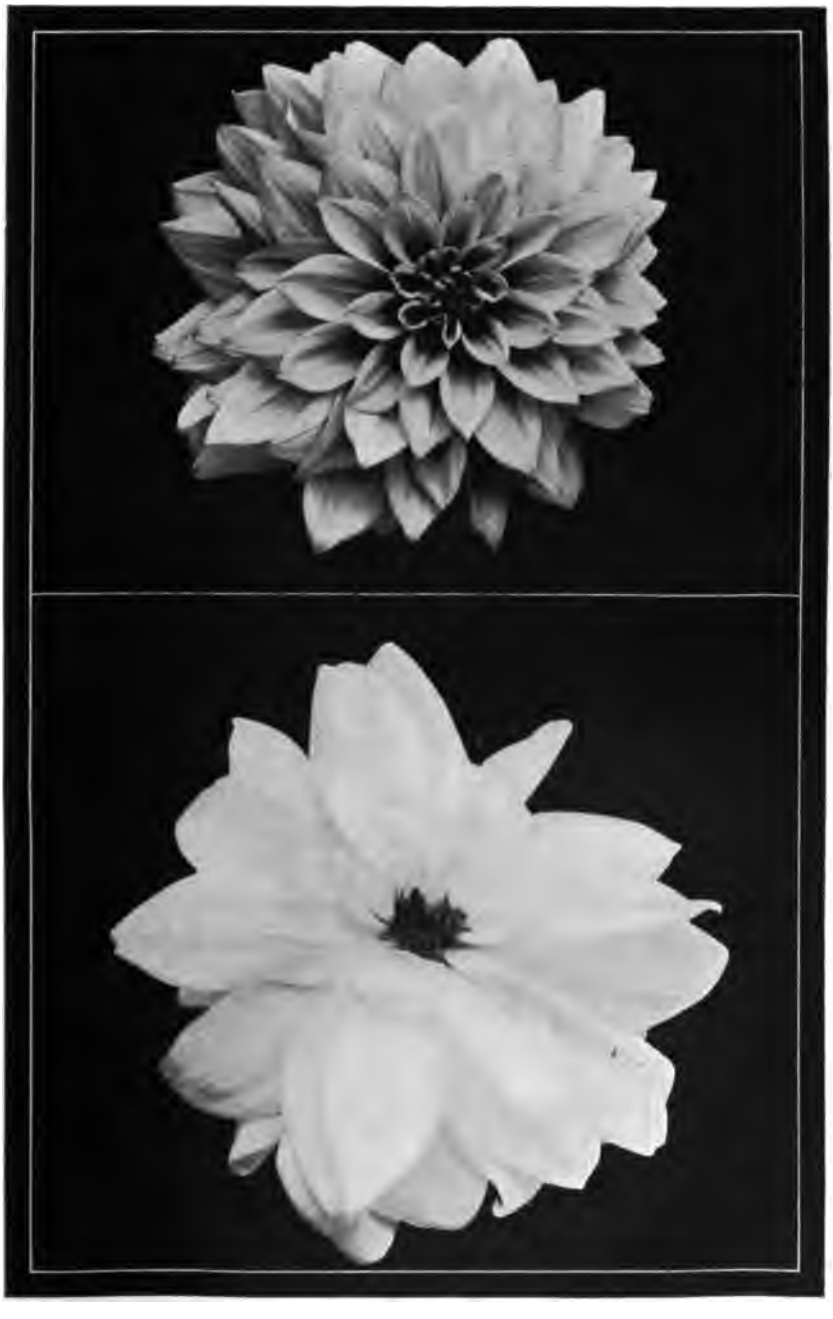

PLATE LI.— DECORATIVE DAHLIA (ABOVE) AND PEONY-FLOWERED DAHLIA (BELOW).

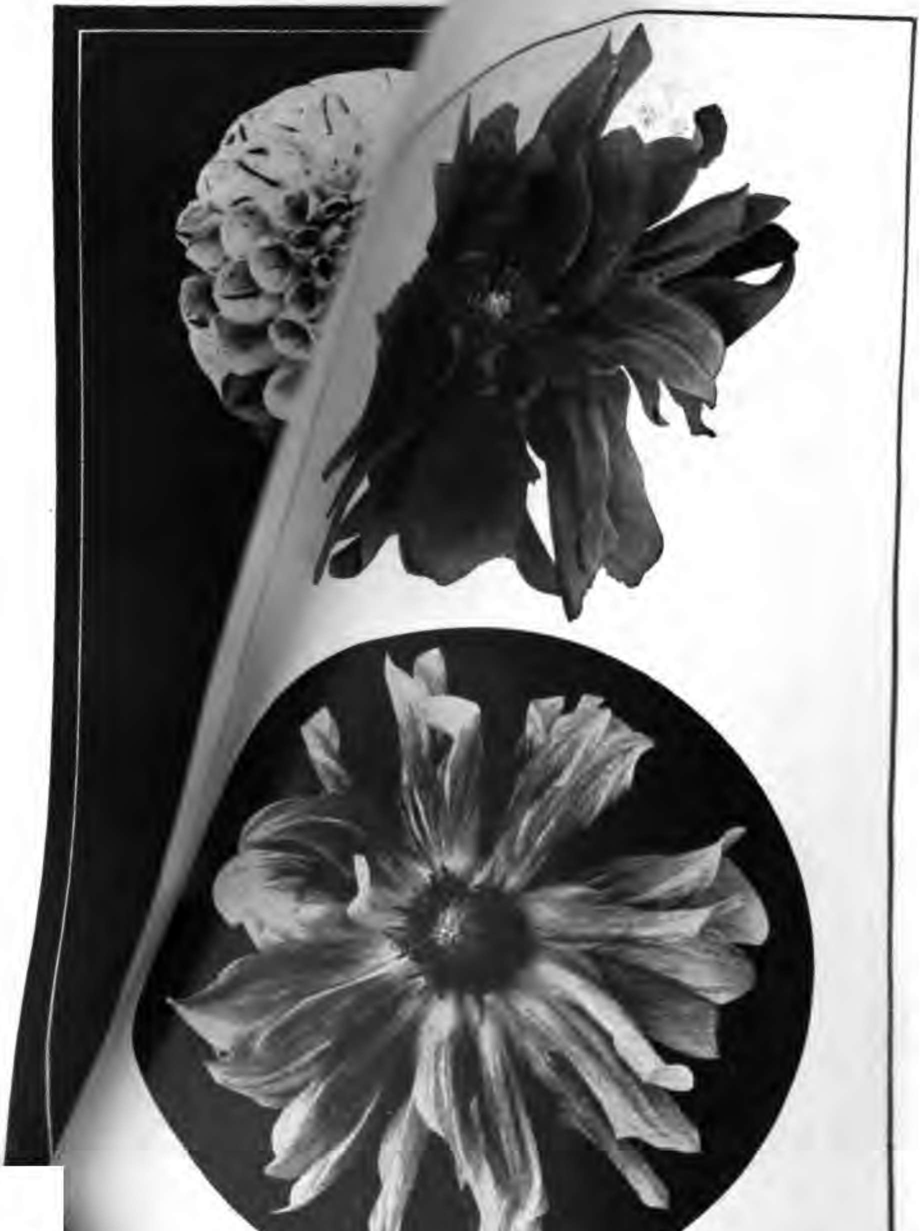

PLATE LII.—PEONY-FLOWERED, OR "ART," DAHLIAS.

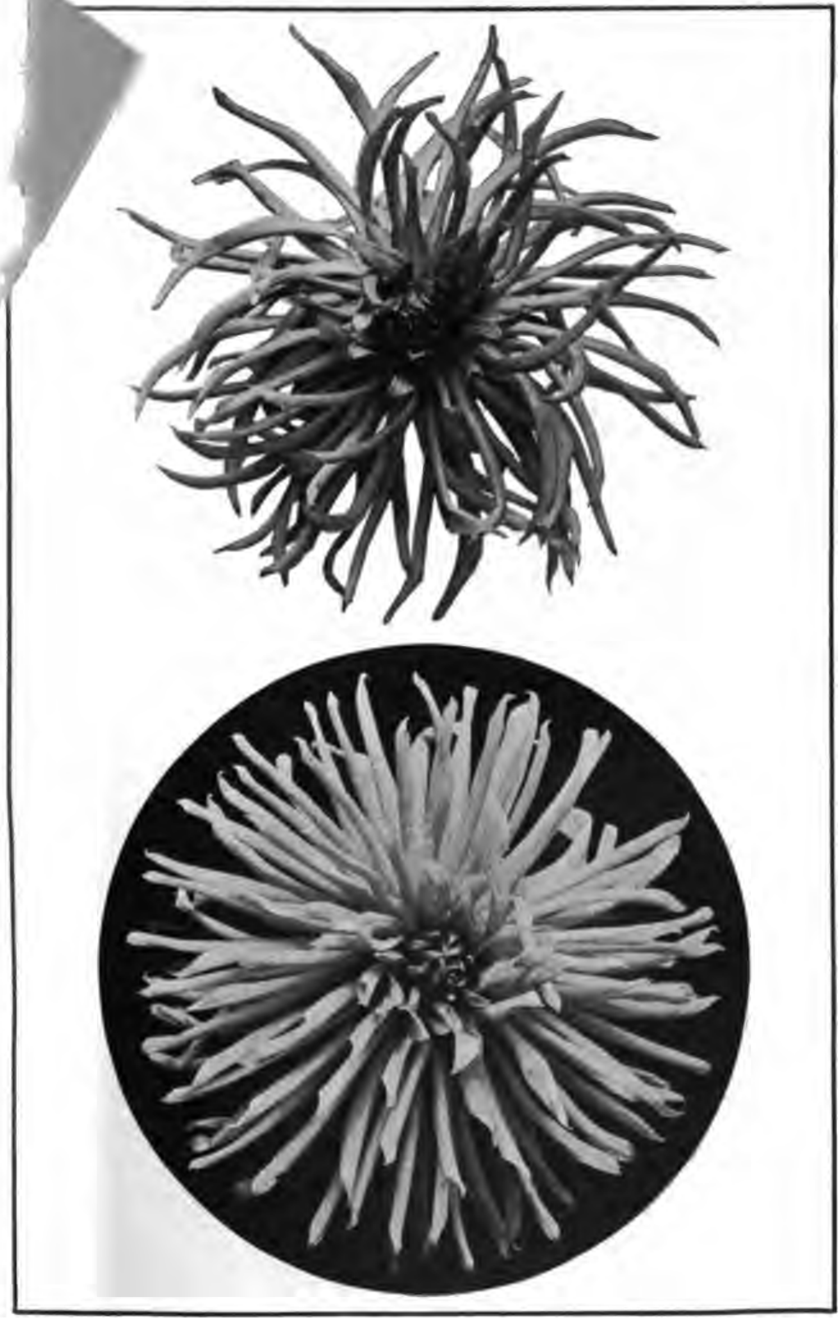

PLATE LIII.—CACTUS DAHLIAS.

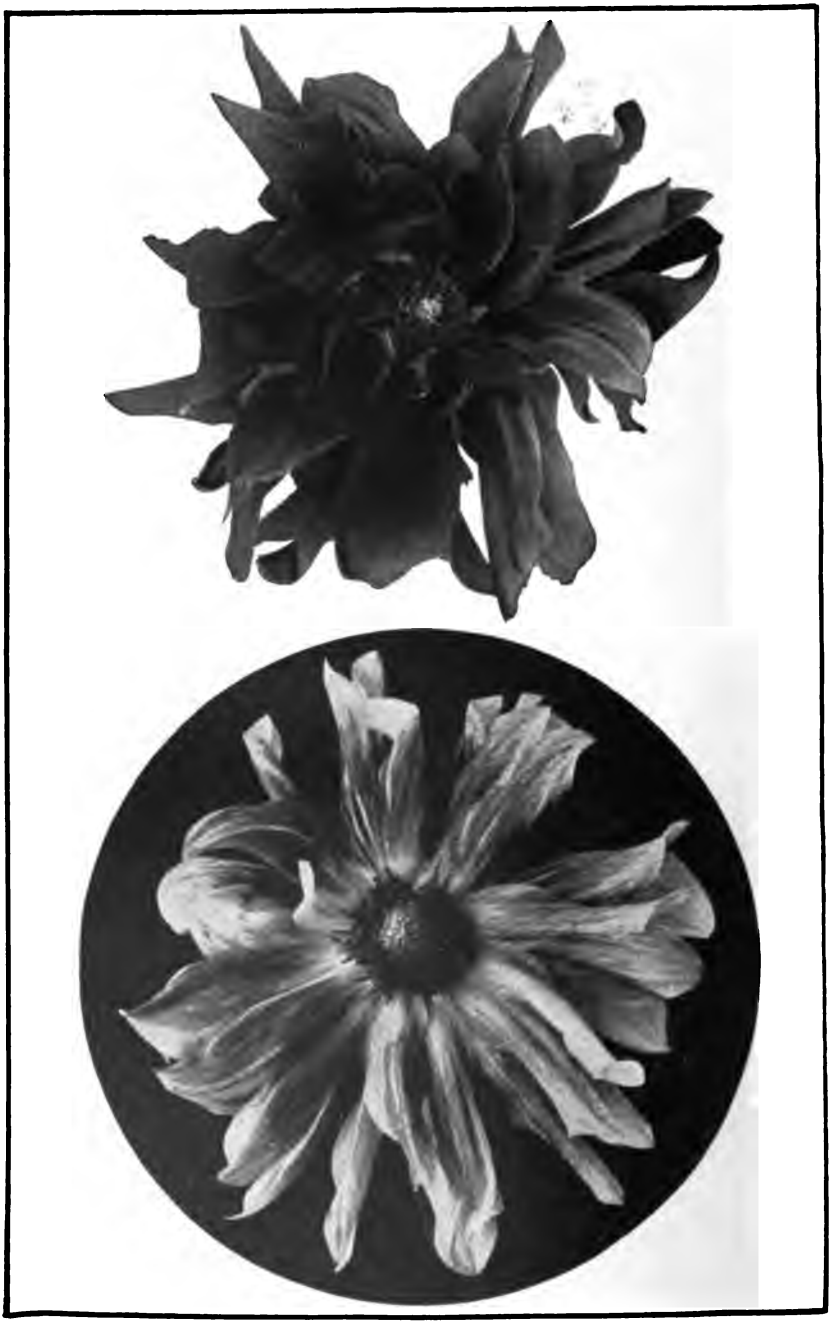

Plate LII.— Peony-flowered, or "Art," Dahlias.

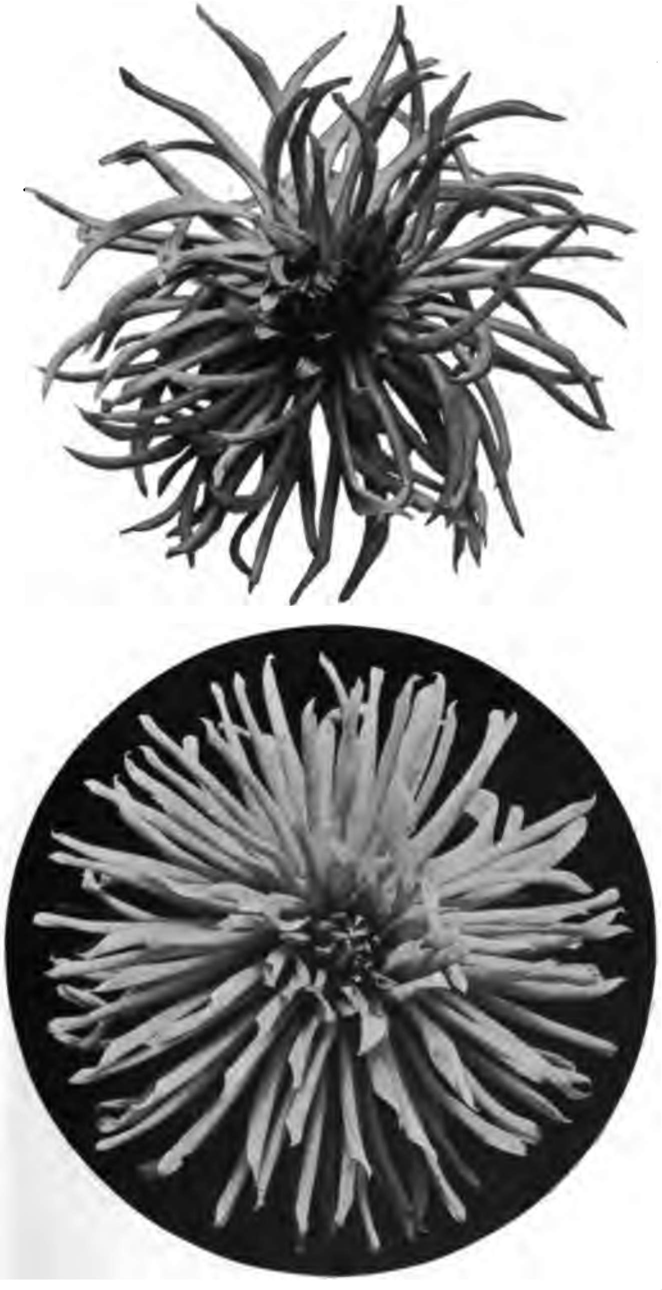

Plate LIII.—Cactus Dahlias.

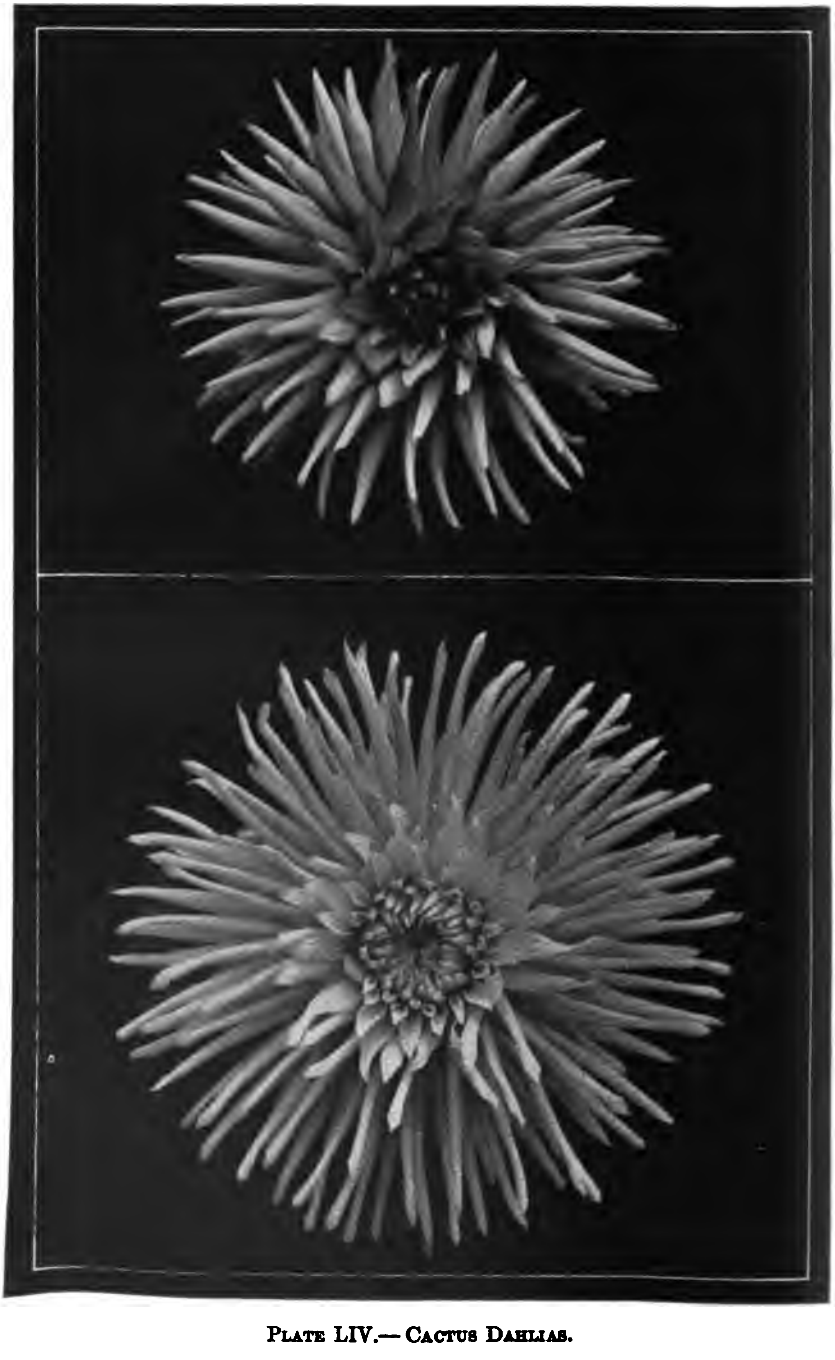

PLATE LIV.— CACTUS DAHLIAS.

CACTUS DAHLIAS.

First group under each color of broad, cactus-hybrid type; second group of true cactus or fluted type. c — cutting, e — exhibition, g — garden.

White — c Bergmann's Silver*, ceg Flora*, ceg Lawine*, ceg Perle de Lyon*, ceg Rheinönig; — g Bridal Robe, cg Candeur, cg Fairy*, ceg Mrs. Douglas Fleming*; Prima Donna* (Eng.), g Schwan*, ce Snowdon*.

Blush to light pink — ceg Galathea*, ceg Mrs. J. P. Mace, ceg Octopus, eg Prima Donna* (Ger.);— ceg Crystal*, eg Delicatissima, eg Extase*, e Gwendoline Tucker*, ceg Mme. Henri Cayeux*, e Onward, cg Satisfaction*. New — Fascination* Mrs. S. T. Wright.

Rose pink to rose color — cg Juliet*, ceg Kriemhilde*, eg Marguerite Bouchon*, cg Pink Pearl*, eg Ruth Forbes*; — eg Empress*, cg Erecta*, ce H. L. Brousson, e Miss Stredwick*, g Stability*, Sweet Briar*, New — Duchess of Marlboro*, Mrs. Henry Randle*.

Rose red to red — e Fred McQuade*, g Mrs. Murray Ind, g Rother*; — ce H. W. Sillem, Stormer*.

Scarlet — cg Amos Perry*, ce Florence Nightingale, ce Ignea*, ceg Kalif*, ceg Lady Fox, ceg Phineas, ceg Rene Cayeux*, cg Standard Bearer*; — Advance*, cg Flame*, cg Foxhunter, ceg Red Admiral*, e John Riding*, eg Mabel Needs, ce Vivid*.

Crimson and carmine — eg Mrs. Ferd. Jeffries; — ceg Brigadier*, e Dr. G. G. Gray, cg Fulgent, cg Germinston*, ceg H. H. Thomas*, eg Nelson*, e Olympic*, cg Progenitor*; ce Wellington*.

Maroon — ceg Dreadnought, ct Fernand Olivet*, cg Floradora*, ceg J. H. Jackson*, g Night, g Othello, ceg Rev. D. R. Williamson*; — ceg Conquest*, e Excelsior, ce Southern Belle*, e The Imp*. New — Geo. L. Stillman*.

Cream and light yellow — ct Goldland*, ceg H. J. Jones*, cg Tante Blanche*; — ceg Aquilla, eg Dr. Roy Appleton*, ceg Mrs. Stephens,* ceg Richard Box*. New — Scorpion*, Nantwich*.

Bright and deep yellow — ceg Buttercup*, ceg Dragon d'Or, ceg Gelber Prins*; ce Stern*; — cg Geneveva*, ceg Glory of Wilts, eg Golden Wave*, c Harold Peerman, ceg Success*, ceg T. G. Baker. New — Golden Gate*, Golden Crown.

Orange — g Harbor Light*, g Prince of Orange, — eg F. H. Chapman*, F. W. Fellowes*, cg Ibis*, eg Miss Wilmott, c Soleil Couchant, ceg Lucifer*, ceg Walter Deegen*.

Buff, amber, pale orange, bronze, terra cotta, etc.— ceg Country Girl*, cg Effective*, ceg Master Carl*, ceg Reliable*, ce Thos. Parkin*, cg Vater Rhein*, ceg Wolfgang von Goethe*; — g Auburn Beauty*, ceg Aurora*, ceg Countess of Kenmare, ce Crepuscule*, ceg Johannesburg*, eg New York*, eg Rev. T. W. Jamieson*, cg Sandy, ceg. Wm. Marshall.

Salmon, old rose, etc.— g Clara G. Stredwick*, ceg Countess of Lonsdale*, eg Dr. Mene, e Hoffnung*, eg Ianthe*, ceg Lady Swaythling*, Mme. Eschenauer*, Niebelungenort*, e Sweetheart, ceg Wodan*; — cg Arthur Pickard*, cg C. E. Wilkins, eg Fred'k Wenham*, ce Marathon*, ceg Sherlock*, ce The Lion.

Lavender, lilac, mauve and violet — cg Chas. Parnot, ct Etna, cg Gustav Schwerits*, e Mauve Queen*, ceg Rosa Starr*, eg Thais*; — cg Clincher*, cg Indomitable*, ceg Kingfisher, ceg Mauve Perfection*, ceg Mrs. T. W. Willis*.

Magenta — cg Earl of Pembroke*, cg Etendard de Lyon*, c Mr. Seagrave; — cg Citizen; e Dorothy Hawes*, ceg Geo. W. Childs.

Purple — ceg Beloit*, c Blaustrumff*, e Great Western*, g Libelle*; — ceg Australian*, cg Eureka, cg Mrs. F. Grinsted*.

Bi-colored: White and red — cg Alpha*, cg Les Alliees, ceg Louis Chauvet, ce Nellie Riding, c Vedette*; — cg Gabriel, cg Gen'l Buller,* ceg Mrs. H. J. Jones; e Leon Varigny*.

Bi-colored: White and yellow — ceg Cockatoo*, cg Minnie West*; ceg Variabilis; — ceg Electric, cg Miss Dorothy Oliver*.

Bi-colored: Yellow and red — cg Else*, ceg Fireworks*, ceg Lyric, ceg Sirius, ceg Tricolor*, ceg Vesuvius*; — ce Jupiter*, ceg Mrs. J. Emberson*.

Bi-colored: White or pink and purple or maroon — eg Mrs. Seale, Nelly Helmsley; —cg Comet*, Elf*, e Victorian.
Other color combinations — ceg Diavolo*, cg Portola*.

POMPON CACTUS.

White — Edelweiss, Snowbird.
Pink — Harzerkind, Tomtit.
Red — Coronation, H. Shoesmith.
Yellow — Goldfinch, Poesie.
Orange — Gluckauf, Zwergsonne.
Lavender, magenta, etc.— Blauling, Blauer Zwerg.
Dark crimson, purple or maroon — Alexander Immer, Crimson Beauty, Mignon, Minima, Zulu.
White and yellow — Gracie, Wunderkind.

DAHLIAS FOR GARDEN DECORATION AND FOR CUTTING.

In a recent dahlia election, inaugurated by *Florists' Exchange*, in which thirty leading dahlia growers or dahlia experts voted, the following varieties received more than two votes each for inclusion in a list of the " twelve best varieties for garden decoration and cutting:"

Votes 14, Geisha; 12, Kalif; 11, Hortulanus Viet; 10, Countess of Lonsdale; 9, Souvenir de Gustav Douzon, and Wodan; 8, Delice; 7, Marguerite Bouchon, Perle de Lyon, Rev. T. W. Jamieson, and W. W. Rawson; 6, A. D. Livoni, Mrs. Roosevelt and Wolfgang von Goethe; 5, F. W. Fellowes, Golden Gate, John Riding, Le Grand Manitou, and Rene Cayeux; 4, Etendard de Lyon, Golden West, Lawine, Souvenir de Chabanne, and Thuringia; 3, Arabella, Dorothy Peacock, Dreer's White, D. M. Moore, Jack Rose, Jeanne Charmet, Caleb Powers, Master Carl, Minnie McCullough, and Sylvia; 3, Aurora, Auguste Nonin, Breezelawn, Chas. Clayton, Duchess of Brunswick, Dr. Peary, Mondschiebe, Mrs. Nath. Slocombe, Niebelungenort, Miss Wilmott, Mrs. Kentwell, Prof. Mansfield, Queen Esther, Robt. Broomfield, T. G. Baker, Walkure, Hampton Court, Rheinkönig, and Yellow Colosse.

CULTURE.

Season.— The dahlia will grow in any part of New York State, but as it makes its best showing late in the summer and early in the fall, the chances for a long season of satisfactory flowering are best where killing frosts are not usual early in the season. This, however, will exclude but few places in the State from the probability of a good showing, for many varieties, even though not set in the field until the middle of June, will flower freely by the end of August if not checked in growth. It is, ordinarily, of little advantage to start dahlias very early; for, under our usual summer conditions, plants well started in the field before the end of May will encounter dry and hot weather in July and August when first ready to bloom. The flowering period is one of special demand for moisture, and this extra demand at a time of scanty supply acts very injuriously upon the plants. The buds blight, either from lack of moisture or from the attacks of plant bugs which become numerous at such times, only few and poor blossoms appear, the stems and branches become hard and woody, new growth is scanty and slow so that the plants become shrub-like rather than luxuriantly herbaceous, and are often a disappointment, not a joy, until cooler weather and fall rains renew the plant from the lower branches and central buds. It is only on vigorous new growth that flowers are produced freely. With shrubby plants very severe pruning, almost to the ground in some cases, is the most effective method of securing bloom; but often by the time the plant is ready to blossom again frosty nights come and the chance of flowers is past for the season.

Meanwhile, plants starting about the middle of June care for themselves much better during the heat and drouth, grow without a check, and when late summer showers stimulate them a little they put forth a full supply of buds and blossoms, which are constantly renewed until the plants are killed by frost. On such plants the foliage may be blackened considerably and the open flowers be ruined by frost yet many buds pass through without harm and later give good blossoms from the sap and plant food held in the juicy stems. If the area devoted to dahlias can be of considerable size, it is well to make a succession of plantings; for occasionally the early plants meet with no check and do magnificently; but " flower themselves out " before the end of the season; when the later set plants serve to extend the period of bloom.

Soil and cultivation.— The soils best suited to dahlias are light rather than heavy, since the original home of the species is the sandy plateaus of Mexico. The sandy loams of eastern Massachusetts, Connecticut, Rhode Island, Long Island, New Jersey and Maryland grow the great majority of the dahlias produced in the eastern United States; but much of the advantage of these locations is probably due to proximity to the ocean, with its influence in retarding frosts and the apparently stimulating effect of the cool breezes from it during the fall nights, and not to the light soil; for fine dahlias may be grown on any type of soil, from these light sands to the heavy clay on which those at the Station are located.

On the lighter soils, manure or other humus-producing materials should be introduced to improve the moisture-holding capacity, while on the heaviest types, coal ashes, sand, or bulky, strawy manure should be used to loosen the texture.

Watering should be avoided if possible, since any cessation of the practice after the plants have become accustomed to constant moistening will lead to checking of growth and scanty flowering. If it becomes really necessary to water, in order to carry the plants over period of drouth, a thorough soaking at weekly or ten-day intervals should be the method, rather than more frequent sprinklings.

On the sandy soils, it is frequently necessary to use nitrogenous fertilizers and phosphoric acid to reinforce the natural fertility; but on heavier types nitrogen should usually be applied sparingly, if at all,— and then just before blooming time,— lest the foliage be stimulated and the plants go " all to leaves," and few blossoms result. It is really surprising to see what a profusion of bloom is often produced on apparently poor soils without additional fertilizing. On any soil the preliminary plowing and other treatment should be deep and thorough, so that the tuber or the roots of the plants may be placed five or six inches below the surface, with as much or more depth of loosened soil below to allow plenty of feeding ground for the roots and room for the formation of new tubers.

The summer cultivation of the dahlia is simple,—like that of potatoes. The surface should be kept thoroughly stirred to hold moisture and to keep down weeds during the early growth of the plants, turning the soil toward the rows at the last in order to keep the tubers well covered. The soil should at no time be allowed to dry out, harden, crust or cake, but by the middle or latter part of August the surface will usually be so shaded by the plants, and the space between plants and rows so narrowed that further cultivation is difficult and ordinarily unnecessary.

Propagation. — Three or four methods are used for obtaining dahlia plants: (1) The clumps of tubers produced in any season are stored over winter in some cool, moderately dry place; and divided when the buds or eyes begin to show in the spring,— in March, April or May, according to the temperature maintained in the storage room. It is not wise to divide until the buds show; as the dahlia tubers are unlike potatoes or sweet potatoes since the eyes are not on the tuber, but on a collar or neck which joins the tuber to the stem, or even on the stem itself; and division before the eyes can be seen is liable to leave tubers without eyes and eyes without tubers,— the first absolutely useless and the second practically so, though expert forcing-house treatment will occasionally secure a plant from an eye or sprout on a small piece of stem. If eyes are numerous as compared with the number of tubers it is well to leave two eyes on each tuber where possible, in order to provide for accidents; but when finally in place in the field one bud to produce one good strong stem to a tuber is much better than more. Some recommend planting the whole clump or half of it to secure added vigor, but the care and constant attention necessary in such cases to keep down additional stems from the buds left is usually not given and a plant results with from two to a dozen stems none of which will give a satisfactory blossom. *One stalk only in a place is best.*

The clumps of some varieties will divide easily, particularly when grown in light soil, so that little more than the fingers may be necessary to separate the tubers and split the stem; but ordinarily a strong, short-bladed knife will be found most convenient, with a mallet to aid in dividing the hard dry stalks; or with some varieties, especially when grown in very heavy soil where the tubers are bunched and stocky, a flat, wide chisel or a bee-keeper's hive tool will prove effective, while a good stout pair of pruning shears is often helpful after the first splitting.

In the field, each tuber should be laid on its side, at the bottom of a hole or furrow deep enough so that the bud or sprout will be five or six inches below the surface. Cover only two inches or so at first, particularly in heavy soil, and fill in as the plant grows.

(2). Green plants are grown in the forcing house. This method is the one most commonly employed in establishing commercial dahlia plantations; for by it many more plants can be secured from a clump than by division. The clump is removed from storage in February or March, placed on the forcing house bench or some similar location, where it can be covered up to the crown with sand, light earth, moss, peat or some other moisture-holding medium. But little or no water is used at first, to avoid danger of rotting the tubers, but a temperature of about 60° should be maintained to start the eyes, after which water is freely applied so that growth of the sprouts may be rapid and vigorous. When these show two or three pairs of leaves, they are removed and used for cuttings, being best started in clean, moist sand with good bottom heat. If only a few plants are needed a portion of the tuber or neck is cut out with the sprout, as this makes tuber formation by the new plant more certain; but if many plants are needed, the cuttings are removed slightly below the first joint above the eye, so that additional buds and sprouts may develop about the base of the stem, from which cuttings can be made in the same way. It is often best to discard the first vigorous, stocky stem, as better results are secured from the slenderer sprouts that follow.

In preparing the cutting for the sand, the stem should be cut with a sharp knife close below or through the base of the joint to insure early rooting and subsequent tuber formation. If the cut is made too far from the joint only small fibrous roots are produced, without good tubers to carry over the next winter. The lowest pair of leaves should also be trimmed off close to the stem. The cutting is then placed nearly up to the second pair of leaves in clean sand on the bench or elsewhere where a bottom heat of about 70° is maintained. The soil should be kept moist, not wet, careful attention should be paid to the ventilation, as stagnant air is fatal, and the plants should be shaded from the sun. The plants should be rooted in about three weeks and can then be grown in pots or flats until needed for field setting, with the usual precautions to prevent " legginess," etc.

Plants thus grown do fully as well, if not better, than those from tubers planted in the field, so far as flower production is concerned; but sometimes fail to make tubers that are satisfactory.

(3) In England, particularly, plants so produced or those from cuttings taken later in the season from larger plants, are grown in pots of small size until they flower and form small tubers which mature normally and are then held until the following spring. Storage problems are thus simplified and these small " pot-roots"

can be transported long distances at slight expense. They make just as good plants as tubers many times their size; and produce normal tubers for storage.

Sometimes, when a very choice variety is to be developed rapidly for distribution, cuttings made from the tubers are grown into plants and second cuttings from those plants are grafted on tubers or pieces of tubers of other varieties. The stem of the cutting is trimmed to a triangular wedge shape, fitted to a corresponding cut in the rooted tuber and held there with raffia. The tuber is then potted and union of the two parts stimulated by bottom heat.

(4) Dahlias are easily grown from seed, but the results are generally disappointing, even with singles, which are best adapted to this style of propagation since they are ordinarily grown for garden decoration where perfection of flower is not so essential. With other types, however, the percentage of good kinds from seedlings is so very small that any one but the enthusiast or the professional breeder soon becomes discouraged.

Breeding dahlias has been to quite an extent left to chance, since hand pollination and scientific control are difficult with flowers of this character. The usual method has been to plant the varieties it was hoped to cross side by side and leave the actual crossing to wind, bees and other insects. However, a method has been announced by the Bureau of Plant Industry of the U. S. Department of Agriculture, whereby pollination can be controlled by washing out the pollen from the female parent by a spray of water, introducing pollen of the chosen male parent and bagging the flower.

If seedlings are to be grown, the seed should be started in March in shallow trays or pans in a forcing house or where similar conditions can be secured, with bottom heat if possible. When the little plants appear the flats should be placed in strong diffused light, not in direct sunlight. The plants are pricked out into deeper trays or pots when the second pair of leaves is showing and the subsequent treatment is like that of plants from cuttings.

March-sown seeds should flower in ample time to allow the grower to select the varieties he desires to test again, and store the tubers.

Planting and training.— The dahlia makes a large plant and must be given plenty of room. A very few varieties will allow setting 2½ x 2½ feet, or 2½ feet in the row in field culture with rows 3 or 4 feet apart; but the great majority of the kinds should not be set closer than 4 by 4 feet if the grower expects to work round them at all during late summer, or to have ready access to them for gathering the flowers; and with some kinds 4 by 5 or even 5 by 5 is advisable for greatest convenience.

If plants are grown normally some system of staking or supporting with wires is almost essential to prevent severe damage from storms; but in commercial field culture this is precluded by the expense. In such fields the plants are placed quite close together, to give mutual support and protection, and are made to grow short and stocky by removing the terminal bud. When two or three pairs of leaves have developed, the bud between the upper pair is pinched out, stopping further extension of the main stalk. This throws the strength of the plant into the lower stem and side branches, so that they resist wind and rain much better; but it delays flowering slightly, since the blossom from the terminal bud is the first to open. If the tubers or plants are set deeply, so that the lower part of the stem is firmly held by the soil, and a good stocky growth is secured, the unsupported plants do fairly well; but under many conditions the side branches split off and lie on the ground so that the flowers are not well displayed.

To secure specially large flowers, thinning and disbudding are necessary, particularly with the show and fancy types, which normally blossom too freely to produce flowers of maximum size. If such blooms are desired, the center bud should be left and not more than six or eight side branches should be allowed to grow, both stem and branches being supported by tying to stakes or wires. All second shoots on the side branches should be pinched out except a few near the terminal bud to continue the flowering after the large blossoms have been removed. The same practice may be followed with the decorative and peony-flowered types, but as these are usually not quite so free blooming as the ball-shaped types, it is not generally considered necessary. When severe disbudding is done, by growing to practically a single stem, as with exhibition chrysanthemums, some huge blossoms are secured, yet without coarseness. Cactus dahlias also may be increased in size by judicious disbudding, but unless the flowers are for exhibition this is hardly an advantage, as many cactus varieties have too much of the "bashful," nodding habit, which extra large size of blossoms may intensify. Single dahlias, except with a few large sorts of the Century type, collarettes, and pompons, are seldom or never disbudded, but the plants are allowed to branch and flower as freely as possible to make attractive garden specimens.

In cutting for bouquets or other floral uses, the work should not be done in the middle of the day, but preferably in the morning, or in the evening. The cut flowers should be "hardened" by removing much of the foliage from the stems, immersing these almost to the blossom in water and keeping them in a cool place until the first wilting due to the cutting has disappeared. With hard-stemmed kinds there is an apparent advantage in placing the stems first in water nearly as hot as the hand will bear, allowing them to remain until the water has cooled and then removing to fresh cold water to which a teaspoonful of salt to a gallon has been added. Water not quite so warm should be used with softer-stemmed flowers.

With many varieties of dahlias sacrifice of buds is often necessary in order to secure satisfactory stems; but is ordinarily not to be deplored, since the dahlia responds very promptly and freely to such trimming and renews the show of flowers quickly if the plants are in good condition. In all cases it is desirable to remove withered and old flowers before seed formation.

All dahlia blossoms should be cut before they have quite reached their best, unless for exhibition, and singles, which are quite short-lived, should be taken before they are fully unfolded, to insure satisfactory retention of petals. The pompon, show and fancy types last longest after cutting, although many of the decoratives are excellent in this regard and some of the cactus and peony-flowered types. The singles are not good for continuous use in bouquets as the petals drop soon after cutting, if fully opened flowers are chosen. The beauty and daintiness of these flowers render them admirable, however, for vase decoration for a dinner or a reception; and their freedom of bloom makes the frequent refilling of the vases in home decoration very easy. Collarette dahlias seem to withstand wilting and hold their petals much better than the singles although apparently differing from them so slightly.

Unfortunately, too many of our handsomest cactus and peony-flowered dahlias are either weak-stemmed, requiring wiring for vase or bouquet use, or are too soft in texture to "hold-up" well after cutting. Breeders are now working, with success in sight in several cases, to overcome these faults, so we may soon hope to have many varieties as satisfactory in these respects as they are in color and form.

Pests.— Fortunately, the dahlia has few serious pests to contend with, though numerous diseases and insects may at times cause annoyance.

No diseases are discussed in any of the published works on the dahlia; but the tubers occasionally rot in the field, though more frequently in storage, from the attacks of fungi; recently there has been reported from various sections a peculiar dwarfing or stunting of plants from some unknown cause, probably from obscure physiological disturbance or from weather injury; and powdery mildew sometimes affects leaves and stems in late summer. This last trouble yields readily to spray treatment.

Insects and some other low forms of animal life are far more troublesome; but ordinarily not serious menaces to dahlia culture.

In moist seasons and in localities where slugs have become common, they are frequently very annoying, as they may eat the bud or the tender sprout below ground, or scrape the outer surface of the lower stem until it is practically girdled and the plant dies. They also occasionally climb the stem and feed on the younger leaves. As they are most active at night and crawl into holes or crevices in the ground or hide under stones or lumps of earth during the day, it is necessary either to hunt them after sundown with a light or to adopt preventive measures. In capturing them, a stick with a darning needle in the end is an effective weapon, from which they may be dropped into a can partly filled with kerosene. They may be driven from the ground about the plant by using a dilute solution of ammonium carbonate (0.75 per ct.) to wet the earth over a small area, and then captured; and it is probable that lime-sulphur solution would act in the same way. They are very fond of bran, so handfuls of this may be used as traps to collect from, or a poisoned bran bait might prove effective where it could be used safely. Should slugs ever become numerous enough to threaten the foliage, spraying with arsenate of lead would be desirable. A few lettuce plants among the dahlias make attractive food for the slugs and may prevent injury to the plants. Lime or dry ashes or napthalene scattered in a small circle about the plant will keep slugs away, but the first two lose much of their effectiveness when wet.

The tarnished plant bug becomes a serious pest during dry, hot summers when the succulence of the dahlia buds and blossoms tempts them from other food plants. When conditions have been right for the increase of these small gray-brown bugs (light green in early stages) they may cause the blighting or deformation of almost every bud by piercing the flower stalk or the base of the bud itself, and may spot and ruin the petals of the buds that do open. Little can be done to control these pests as they are sucking insects, so not subject to poisoning, and too alert and lively in movements to make spraying with contact insecticides practicable. The only thing to do is to protect very choice plants or blossoms with close-mesh netting and to await the disappearance of the insect, which usually accompanies the cool September nights.

The red spider and black and green aphids are sometimes troublesome, but can easily be controlled by spraying, the former with cold water merely, the latter with a weak nicotine or strong soap solution.

Borers occasionally work in the stalks, but can usually be removed without harm to the plant if the injury is noticed in time, by splitting the stalk with a sharp knife and killing the borer.

During 1915 the Station collection suffered not only from slugs and tarnished plant bugs but also quite seriously, in August and September, from the ravages of a small black Capsid, which worked deep in the heart of the flower, from the striped cucumber beetle and the beetle of the southern corn root worm and from grasshoppers; but these insects have not been reported as menacing dahlias elsewhere.

Care of tubers. — Dahlia tubers should not be dug until they have matured as much as possible, but must not be left in the ground long enough to be in danger of freezing. The plants are often lightly touched by frost in September or early October, but are not ordinarily injured severely until late October. They should stand for a few days after killing frost to allow the tubers to utilize the plant food in the stems. The stems should then be cut off, with pruning shears, corn cutter, grass hook or similar tool, close to the surface of the ground, which will leave from four to six inches of stem attached to the clump. The clumps should then be lifted with spade or spading fork, inserting the tool in the ground at least eight inches from the stem, since the tubers of many varieties extend far out into the soil. The loose dirt may be removed from the clump by jarring if the soil is light, or by means of a blunt-pointed stick if the soil is heavy and closely packed about the tubers. It is only necessary to remove enough to make handling the clumps easy, as some dirt about the base of the stem is an advantage if stored in dry places. The clumps should be exposed to sun and air for a few hours to remove surplus moisture and then removed to winter quarters.

The storage room should be moderately dry and with a temperature ranging between 40° and 50° if possible, under which conditions it is only necessary to place the clumps, with the stems down, in boxes, barrels or bins, or in a loose pile on the floor of the cellar or other storage room. The smaller clumps should be placed at the bottom where there is least danger of drying out, and the heavy-tubered, succulent-stemmed clumps on the outside of the pile. If the temperature is liable to rise much above 50° for any considerable time or if other conditions tend to drying out of the tubers, the clumps should be buried in moist, not wet, sand, fine coal ashes, sawdust or similar materials which will aid in maintaining uniform conditions and prevent shriveling of the tubers from drying. Any excess of moisture should be avoided, as favoring the growth of rot-producing fungi.

If the tubers on any of the plants are very small, they should be kept separately, and buried in sand, which is moistened occasionally to keep the tubers in good plump condition. A good method of moistening is to cover the sand with two or three layers of heavy paper, like builders' paper, and soak this thoroughly with water.

I. INSPECTION OF AGRICULTURAL SEEDS.

Part I of this Bulletin gives the results of the analyses of the official samples of agricultural seeds collected during the year 1914. These samples were collected under the provisions of Article 15 of the Agricultural Law and were transmitted for analysis to the Director of the New York Agricultural Experiment Station, in accordance with the provisions of Section 341 of said law.

These analyses and other additional information are published by the Director in accordance with said Section 341. Article 15 of the Agricultural Law, or what is known as the " Seed Law " will be found below, printed in full.

Following the tables are given, (1) the method of analysis employed in making these tests, (2) the requirements of the agricultural seed law, and, lastly, (3) a discussion of the results of the inspection of seeds and its significance to New York farmers.

PROVISIONS OF THE AGRICULTURAL LAW RELATIVE TO THE INSPECTION AND SALE OF AGRICULTURAL SEEDS.

ARTICLE 15 OF THE AGRICULTURAL LAW.

INSPECTION AND SALE OF SEEDS.

Section 340. Inspection and sale of seeds.
341. Samples, publication of results of examination.

§ 340. **Inspection and sale of seeds.** Within the meaning of this article " agricultural seeds " are defined as the seeds of alfalfa, Canadian blue grass, Kentucky blue grass, alsike clover, crimson clover, red clover, white clover, vetch, orchard grass, rape, red top, and timothy which are to be used for sowing or seeding purposes. No person, firm or corporation shall sell, offer, expose or have in his possession for sale for the purpose of seeding, any seeds of grasses or clovers, of the kind known as agricultural seeds containing in excess of three per centum by weight of foul or foreign seeds, unless every receptacle, package, sack or bag containing such seeds is plainly marked or labeled with the per centum of such foul or foreign seeds contained therein. (As amended by chapter 59 of the Laws of 1914.)

§ 341. **Samples, publication of results of examination.** The commissioner of agriculture or his duly authorized representatives shall take samples of seed in triplicate in the presence of at least one witness and in the presence of such witness shall seal such samples and shall at the time of taking tender, and if accepted, deliver to the person apparently in charge one of such samples; one of the other samples the commissioner of agriculture shall cause to be analyzed. The director of the New York agricultural experiment station shall analyze or cause to be analyzed such samples of seeds taken under the provisions of this article as shall be submitted to him for that purpose by the commissioner of agriculture and shall report such analysis to the commissioner of agriculture, and for this purpose the New York agricultural experiment station may employ experts and incur such expenses as may be necessary to comply with the requirements of this article. The result of the analysis of the sample or samples so procured, together with such additional information as circumstances advise, shall be published in reports or bulletins from time to time.

REPORT OF ANALYSES OF SAMPLES OF SEEDS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1914.

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	ALFALFA:			
1037	Alfalfa Maurer-Haap Co., Rochester.	.04	.14	99.82
1658	Alfalfa D. L. Ramsey, Auburn.	.04	.71	99.25
519	Alfalfa E. N. Dexter & Co., Morrisville.	.04	.21	99.75
850	Alfalfa Harskaline H. Collins, Mertinsia.	.02	.14	99.84
1268	Alfalfa Geo. W. Peck Co., Penn Yan.	.22	.36	99.42
1357	Alfalfa Wm. L. Potvin, Hudson Falls.	.08	.24	99.68
1409	Alfalfa Clyde Farmers Exchange, Clyde.	.04	.66	99.30
1436	Alfalfa Wm. H. Ferguson & Son, Elmira.	.18	.19	99.63
1476	Alfalfa John H. Westerman, Walden.	None	.06	99.94

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	ALFALFA (*continued*):			
1652	Alfalfa Dean Dillingham & Co., Auburn.	.08	.32	99.60
1446	Ace Merton Baldwin, Wellsburg.	.02	.10	99.88
1464	Ace Matthews & Harrison, Kingston.	.04	.03	99.93
836	Anchor Wm. Hamilton & Son, Caledonia.	.08	.02	99.90
812	Berry Dorchester & Rose, Geneva.	.04	.12	99.84
831	Best Edward C. Reeves, Palmyra.	.11	.20	99.69
1029	D. B E. F. Dibble, Honeoye Falls.	.12	.02	99.86
1034	Empire Burr & Starkweather Co., Rochester.	.08	.14	99.78
1660	Empire T. C. McCormick & Son, Kings Ferry.	.04	.18	99.78
1656	Fancy Auburn Flour & Feed Co., Auburn.	.60	.88	98.52
527	Fancy Frank T. Benjamin & Co., Canastota.	.04	.16	99.80
1045	Fancy G. W. Hickox & Son, Batavia.	.12	.46	99.42
1402	Fancy Marshall, Barrick Co., Inc., Lyons.	.12	.04	99.84
929	G Chas. F. Saul, Syracuse.	.04	.20	99.76
1429	Gandy's Fred Smith, Elmira.	.01	.11	99.88
1655	Onondaga Auburn Flour & Feed Co., Auburn.	.08	.24	99.68
930	Onondaga Chas. F. Saul, Syracuse.	.04	.06	99.90
1158	Pine Tree A. J. Schweinsberg, Boonville.	.18	.10	99.72
1416	Pine Tree Gipson Mead, Savannah.	.04	.10	99.86
	ALSIKE CLOVER:			
1503	Alsike John R. Hunt, Ellenville.	6.28	.34	90.58
809	Alsike R. A. Mather, Canandaigua.	1.92	1.10	96.98
813	Alsike William Wilson, Geneva.	7.97	.80	91.23
818	Alsike Joseph Ireland, Perry.	2.81	.50	96.69

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	ALSIKE CLOVER (*continued*):			
833	Alsike Wm. Hamilton & Son, Caledonia.	1.25	1.65	97.10
1014	Alsike Brewster, Crittenden & Co., Rochester.	1.28	.25	98.47
1013	Alsike Brewster, Crittenden & Co., Rochester.	2.56	.15	97.29
1018	Alsike Brewster, Crittenden & Co., Rochester.	1.31	.20	98.49
1022	Alsike Albert W. Gilman, Rochester.	1.82	.40	97.78
1291	Alsike Geo. W. Peck Co., Bath.	5.97	.55	93.48
1275	Alsike Geo. W. Peck Co., Cohocton.	7.08	.92	92.00
1473	Alsike J. W. Matthews & Co., Newburgh.	7.92	.42	91.66
1404	Alsike Philip Deuchler & Son, Lyons.	2.00	1.00	97.00
1355	Alsike Wm. L. Potvin, Hudson Falls.	3.34	.47	96.19
1015	Alsike Brewster Crittenden & Co., Rochester.	5.55	.17	94.28
847	Alsike John De Frine, Williamson.	3.12	.50	96.38
842	Alsike Harvey & Howes, Ionia.	7.12	.47	92.41
1298	Alsike Geo. W. Rockwell, Horseheads.	2.25	.85	96.80
1267	Alsike Geo. W. Peck Co., Penn Yan.	5.50	.75	93.75
413	Alsike C. E. Palmer, Ransomville.	10.56	.57	88.87
1279	Alsike Clarence J. Tierney, Wallace.	1.62	.10	98.28
1401	Alsike Beekman, Clary & Van Liew, Dundee.	2.25	1.35	92.61
1203	Alsike W. G. Hill, Attica.	6.04	1.35	92.61
1155	Ace A. J. Schweinsberg, Boonville.	6.50	.25	93.25
1046	Ace G. W. Hickox & Son, Batavia.	3.59	.75	95.66
1553	Ace G. L. Dana, Cobleskill.	1.40	.17	98.43
1283	Ace Tucker & Line, Wallace.	3.45	.70	95.85
1467	Ace Matthews & Harrison, Kingston.	1.65	.25	98.10

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	ALSIKE CLOVER (*continued*):			
830	Bell Edward C. Reeves, Palmyra.	5.60	.04	94.36
1442	Best William T. Coleman, Elmira.	1.52	.25	98.23
1297	Choice C. M William M. Killigrew, Corning.	7.02	.60	92.38
1438	Choice William H. Ferguson & Son, Elmira.	9.12	3.65	87.23
1408	Choice Clyde Farmers Exchange, Clyde.	5.50	.40	94.10
1030	D. B E. F. Dibble, Honeoye Falls.	1.28	.75	97.97
1551	Diamond David C. Lawyer, Cobleskill.	1.15	.11	98.74
1501	Fancy C. D. Wait, Montgomery.	4.05	1.00	94.95
1411	Fancy Alfred R. Ketchum & Daniel P. Maloy, Clyde.	.50	.10	99.40
1259	Fancy Horton & Crosin, Penn Yan.	2.79	.45	96.76
1038	Fancy Maurer-Haap Co., Rochester.	1.44	1.45	97.11
806	Fancy Perry C. Shafer Co., Brockport.	2.72	.15	97.13
1430	Gandy's Fred Smith, Elmira.	3.62	.60	95.78
1288	Gem Avoca Hardware Co., Avoca.	3.90	.60	95.50
1413	Globe Gipson Mead, Savannah.	1.40	.35	98.25
1154	Kaiser A. J. Schweinsberg, Boonville.	6.82	.60	92.58
525	No. 10 Frank T. Benjamin & Co., Canastota.	6.75	.30	92.95
1035	No. 2 Canadian Burr & Starkweather Co., Rochester.	.96	.95	98.09
1457	Reliable Goshen Hardware Co., Goshen.	2.24	.10	97.66
1163	Reliable C. H. Payne, Stittville.	3.17	.35	96.48
1207	Safe Miller, Crozier & Co., Canisteo.	1.85	.90	97.25
829	Strictly Prime Crane, Luce & Co., Marion.	2.98	.38	96.64
1403	Sun Philip Deuchler & Son, Lyons.	2.35	.55	97.10

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	ALSIKE CLOVER (*continued*):			
1453	Vicar L. R. Wallace, Middletown.	1.31	.70	97.99
1205	Vicar L. A. Davis, Arcade.	2.40	.85	96.75
1302	Vicar Samuel L. Roulston & Son, Gouverneur.	1.00	.40	98.60
	RED CLOVER:			
1204	A. B. A. Medium Charles M. Davis, Varysburg.	.54	.24	99.22
1474	Ace W. R. Perkins & Co., Newburgh.	.58	.54	98.88
1417	Ace Maurice E. Hadden, Savannah.	.66	.34	99.00
1266	Ace Medium Kelly & Corcoran, Penn Yan.	.18	.40	99.42
1047	Ace Medium G. W. Hickox & Son, Batavia.	1.05	.44	98.51
934	Ace Medium Chas. F. Saul, Syracuse.	.54	.50	98.96
1153	Ace A. J. Schweinsberg, Boonville.	.50	.40	99.10
1274	Anchor Medium W. H. Clark & Co., Cohocton.	.04	.10	99.84
1044	Anchor S. G. Crump & Son, Pittsford.	.18	.30	99.52
927	Apex Mammoth Chas. F. Saul, Syracuse.	.50	.20	99.30
1356	Arc Mammoth Wm. L. Potvin, Hudson Falls.	.30	.50	99.20
1050	Arc Medium Perry C. Shafer Co., Brockport.	.09	.46	99.45
1478	Atlas Medium Kniffin & Hopkins, Goshen.	1.52	.52	97.96
860	Atlas Medium Weldon F. Weston & Co., Beacon.	1.80	.44	97.76
1256	Best Medium Estate of H. S. Schoonmaker, Seneca Castle.	.48	.18	99.34
526	Choice Mammoth Frank T. Benjamin & Co., Canastota.	1.36	.42	98.22
1460	Choice Snyder Fancher Co., Middletown.	1.65	.88	97.47
937	Choice Mammoth Recleaned Chas. F. Saul, Syracuse.	.32	.44	99.24
938	Choice Medium Recleaned Chas. F. Saul, Syracuse.	.70	.50	98.80
838	Climax Mammoth Alex. Davison, Canandaigua.	.34	.35	99.31

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	RED CLOVER (*continued*):			
1449	Climax Medium Russell & Co., Watkins.	.25	.22	99.53
1039	Climax Medium Briggs Bros., Rochester.	1.80	.40	97.80
1448	Crown Mammoth John I. Ford & Son, Chemung.	.32	.42	99.26
1360	Crown Medium Albert V. Brayton, Glens Falls.	.86	.28	98.86
1025	D. B. Mammoth E. F. Dibble, Honeoye Falls.	.63	.02	99.35
1026	D. B. Medium E. F. Dibble, Honeoye Falls.	2.79	.40	96.81
1021	Elk Medium Albert W. Gilman, Rochester.	.84	.14	99.02
1452	Elk L. R. Wallace, Middletown.	.24	.34	99.42
804	Eureka Medium Perry C. Shafer Co., Brockport.	.45	.26	99.29
1261	Eureka Medium Horton & Crosin, Penn Yan.	1.32	.30	98.38
1255	Fancy Bridge & Wilcox, Phelps.	.18	.28	99.54
1265	Fancy Kelly & Corcoran, Penn Yan.	.57	.10	99.33
1254	Fancy Mammoth Bridge & Wilcox, Phelps.	.21	.10	99.69
1202	Fancy Mammoth Fish, Burns & Fish, Alton.	.04	.30	99.66
1657	Fancy Mammoth D. L. Ramsey & Son, Auburn.	.18	.16	99.66
1262	Fancy Mammoth Kelly & Corcoran, Penn Yan.	.21	.22	99.57
820	Fancy Medium Rowe & Kennedy, Canaseraga.	.69	.23	99.08
1654	Fancy Medium Smith Bros. Seed Co., Inc., Auburn.	.08	.12	99.80
1201	Fancy Medium Fish, Burns & Fish, Alton.	.34	.20	99.46
1412	Fancy Medium Alfred R. Ketchum & Daniel P. Maloy, Clyde.	.76	.08	99.16
1264	Fancy Medium Kelly & Corcoran, Penn Yan.	.12	.30	99.58
1407	Gandy's Fancy No. 10 Philip Deuchler & Son, Lyons.	.32	.10	99.58
1282	Gandy's Standard "A" Fancy Mammoth Clarence J. Tierney, Wallace.	.22	.24	99.54

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	RED CLOVER (*continued*):			
1281	Gandy's Standard "A" Fancy Medium Clarence J. Tierney, Wallace.	.30	.16	99.54
1653	Gay Dean Dillingham & Co., Auburn.	1.28	.50	98.22
1290	Gem Mammoth Avoca Hardware Co., Avoca.	.52	.34	99.14
926	Gem Mammoth Byron L. Grant & Son, Cortland.	.61	.51	98.88
1289	Gem Medium Avoca Hardware Co., Avoca.	.24	.30	99.46
1296	Globe Mammoth Geo. W. Peck Co., Corning.	.24	.44	99.32
814	Globe Medium John Holley Bradish, Batavia.	.39	.32	99.29
1294	Globe Medium James Faucett, Bath.	.20	.21	99.59
828	Green Medium Charles A. Sessions & Son, Palmyra.	.35	.25	99.40
1286	Honor Medium John W. Waters, Avoca.	.50	.30	99.20
827	Honor Medium Tuttle & Co., Palmyra.	.08	.16	99.76
1285	Honor Mammoth John W. Waters, Avoca.	.75	.13	99.12
1152	Kaiser A. J. Schweinsberg, Boonville.	.72	.50	98.78
1468	Kaiser Mammoth Matthews & Harrison, Kingston.	.30	.46	99.24
1469	Kaiser Medium Matthews & Harrison, Kingston.	1.34	.88	97.78
1439	Kaiser Mammoth Decker E. Ayres & Chas. E. Knapp, Elmira.	.80	.32	98.88
1468	Kaiser Mammoth Matthews & Harrison, Kingston.	.30	.46	99.24
1271	Lion Mammoth Kimmel Hardware Co., Wayland.	.34	.15	99.51
848	Lion Medium William H. Paddock, Wolcott.	.50	.56	98.94
1272	Lion Medium Kimmel Hardware Co., Wayland.	.40	.26	99.34
1443	Mammoth Merton Baldwin, Wellsburg.	.94	.30	98.76
1276	Mammoth Clarence J. Tierney, Wallace.	.12	.54	99.34
1277	Mammoth Clarence J. Tierney, Wallace.	.10	.31	99.59
524	Mammoth Buyea & Standt, Oneida.	.36	.66	99.98

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	COMPOSITION.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	RED CLOVER (*continued*):			
1428	Mammoth Fred Smith, Elmira.	1.14	.76	98.10
1440	Mammoth William T. Coleman, Elmira.	.54	.30	99.16
1041	Mammoth Joseph Fritts, Darien Center.	.42	.20	99.38
835	Mammoth William Hamilton & Son, Caledonia.	.14	.10	99.76
834	Medium William Hamilton & Son, Caledonia.	.76	.50	98.74
839	Medium Alex. Davison, Canandaigua.	.20	.42	99.38
1042	Medium Joseph Fritts, Darien Center.	1.20	.26	98.54
931	Medium Chas. F. Saul, Syracuse.	1.00	.56	98.44
935	Medium Chas. F. Saul, Syracuse.	1.64	.36	98.00
1251	Medium Chas. E. Zartman, Waterloo.	.84	.26	98.90
1427	Medium Fred Smith, Elmira.	1.77	.50	97.73
1441	Medium William T. Coleman, Elmira.	.40	.21	99.39
1433	Medium William H. Ferguson & Son, Elmira.	1.32	.68	98.00
933	Onondaga Medium Chas. F. Saul, Syracuse.	.18	.20	99.62
936	Onondaga Medium Chas. F. Saul, Syracuse.	.36	.20	99.44
1461	Pan American Everett & Treadwell, Kingston.	.74	.66	98.60
1462	Pan American Mammoth Everett & Treadwell, Kingston.	.92	.44	98.64
1300	Pan American Medium Geo. W. Rockwell, Horseheads.	1.61	1.14	97.25
1299	Pan American Mammoth Geo. W. Rockwell, Horseheads.	1.06	.74	98.20
821	Par Medium J. H. Colgrove, Canaseraga.	.51	.25	99.24
825	Par Mammoth J. H. Colgrove, Canaseraga.	.18	.30	99.52
924	Paragon The Forrest Seed Co., Inc., Cortland.	.82	.44	98.74
859	Paragon Mammoth Weldon F. Weston & Co., Beacon.	1.84	.40	97.76
521	Pea Vine E. N. Dexter & Co., Morrisville.	.19	.18	99.63

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	RED CLOVER (*continued*):			
1257	Pine Tree Mammoth Horton & Crosin, Penn Yan.	.21	.06	99.73
807	Pine Tree Medium R. A. Mather, Canandaigua.	.78	.02	99.20
1258	Pine Tree Medium Horton & Crosin, Penn Yan.	1.59	.40	98.01
808	Pine Tree Mammoth R. A. Mather, Canandaigua.	.27	.14	99.59
1470	Plum J. W. Matthews & Co., Newburgh.	.50	1.40	98.10
1252	Premier Medium Maloney Bros., Waterloo.	.03	.23	99.74
822	Premier Medium J. H. Colgrove, Canaseraga.	.21	.40	99.30
826	Premier Mammoth J. H. Colgrove, Canaseraga.	.03	.20	99.77
1405	Prime Medium Philip Deuchler & Son, Lyons.	.21	.20	99.59
810	Prime Medium Dorchester & Rose, Geneva.	.33	.34	99.33
1406	Prime Mammoth Philip Deuchler & Son, Lyons.	.18	.06	99.76
811	Prime Mammoth Dorchester & Rose, Geneva.	.42	.20	99.38
1278	Reliable Mammoth Clarence J. Tierney, Wallace.	.31	.20	99.49
816	Reliable Medium George C. Broadbooks, Attica.	1.53	.96	97.51
1162	Reliable Medium C. H. Payne, Stittville.	.75	.50	98.75
1456	Reliable Medium Goshen Hardware Co., Goshen.	2.99	.52	96.49
845	Royal Medium John De Frine, Williamson.	.33	.44	99.23
1019	Star Mammoth Brewster, Crittenden & Co., Rochester.	1.17	.50	98.33
1020	Star Medium Brewster, Crittenden & Co., Rochester.	.81	.34	98.85
1269	Star Medium Geo. W. Peck Co., Penn Yan.	.40	.24	99.36
1049	Value Medium Perry C. Shafer Co., Brockport.	.18	.30	99.52
	WHITE CLOVER:			
1426	White Clover Geo. W. Peck Co., Elmira.	8.02	.85	91.13
1415	Choice	1.27	.60	98.13

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	COMPOSITION.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	SWEET CLOVER:			
1024	White Blossom E. F. Dibble, Honeoye Falls.	.04	.15	98.80
1437	Yellow Blossom Wm. H. Ferguson & Son, Elmira.	.96	.46	98.58
	BLUE GRASS:			
1552	Canadian David C. Lawyer, Cobleskill.	2.32	3.75	93.93
1422	English, Poceys Fred. L. Jennings, Elmira.	.60	.30	99.10
844	Kentucky E. F. Dibble, Honeoye Falls.	.60	12.60	86.80
1502	Kentucky John R. Hunt, Ellenville.	1.32	8.10	90.58
1425	Kentucky Geo. W. Peck Co., Elmira.	1.45	21.05	77.50
1431	Kentucky Fred Smith, Elmira.	1.35	16.80	81.85
1659	Kentucky D. L. Ramsey & Son, Auburn.	.30	22.20	77.50
1031	Kentucky E. F. Dibble, Honeoye Falls.	.30	9.00	90.70
	ORCHARD GRASS:			
1032	Fancy E. F. Dibble, Honeoye Falls.	.52	14.65	84.83
1423	Orchard Grass Fred. L. Jennings, Elmira.	1.05	10.05	88.90
1432	Orchard Grass Fred Smith, Elmira.	2.85	19.45	77.70
1444	Prime Merton Baldwin, Wellsburg.	1.85	13.95	84.20
	RAPE:			
1040	Dwarf Essex Briggs Bros., Rochester.	.04	.25	99.71
1410	Dwarf Essex Clyde Farmers Exchange, Clyde.	.04	.42	99.54
	RED TOP:			
1458	Red Top Snyder Fancher Co., Middletown.	12.13	16.68	71.19
1157	Ace A. J. Schweinsberg, Boonville.	1.19	9.40	89.41
1554	Ace G. L. Dana, Cobleskill.	.71	8.51	90.78
1421	Ace Fred. L. Jennings, Elmira.	.67	11.18	88.15

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	RED TOP (*continued*):			
1479	B Fancy Kniffin & Hopkins, Goshen.	9.75	12.60	77.65
1455	Choice Goshen Hardware Co., Goshen.	1.44	16.10	82.46
1027	D. B E. F. Dibble, Honeoye Falls.	.70	9.70	89.60
840	Fancy Rufus A. Mather, Canandaigua.	.90	5.50	93.60
861	Fancy Weldon F. Weston & Co., Beacon.	11.05	20.45	68.50
1206	Fancy Miller, Crozier & Co., Canisteo.	.75	2.57	96.68
1471	Fancy J. W. Matthews & Co., Newburgh.	5.37	10.05	84.58
1424	Fancy Geo. W. Peck Co., Elmira.	.65	6.55	92.80
1414	Globe Gipson Mead, Savannah.	.50	2.45	97.05
1445	Unhulled Merton Baldwin, Wellsburg.	.61	39.00	60.39
	TIMOTHY:			
1263	Acme Kelly & Corcoran, Penn Yan.	.05	.05	99.90
1435	Anchor Wm. H. Ferguson & Son, Elmira.	2.15	1.35	96.50
666	Arrow Samuel Harley, Grand Gorge.	.41	.30	99.29
1477	Arrow Kniffin & Hopkins, Goshen.	.45	.40	99.15
1280	Arrow Clarence J. Tierney, Wallace.	.60	.50	98.90
1209	Bard Miller, Crozier & Co., Canisteo.	.50	1.45	98.05
532	Bingo J. De Ver Rogers & Son, Oxford.	.04	.05	99.91
1651	Bingo Ward Bros., Moravia.	.05	.11	99.84
1358	Bingo A. V. Brayton, Glens Falls.	.10	.05	99.85
823	Bingo J. H. Colgrove, Canaseraga.	.07	.05	99.88
1434	Bison Wm. H. Ferguson & Son, Elmira.	.35	.75	98.90
1466	Bison Matthews & Harrison, Kingston.	.90	1.25	97.85
530	Bison George B. Fletcher, Oxford.	1.10	1.05	97.85

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	TIMOTHY (*continued*):			
1419	Bon Fred. L. Jennings, Elmira.	.20	.15	99.65
1023	Bon A. W. Gilman, Rochester.	.05	1.15	98.80
1418	Choice Maurice E. Hadden, Savannah.	.80	.85	98.35
523	Choice Buyea & Standt, Oneida.	.11	.10	99.79
928	Choice Chas. F. Saul, Syracuse.	.30	.30	99.40
1447	Colonial Merton Baldwin, Wellsburg.	.30	.40	99.30
932	Columbia Chas. F. Saul, Syracuse.	.07	.10	99.83
1028	D. B. E. F. Dibble, Honeoye Falls.	.72	.10	99.18
846	Eagle John De Frine, Williamson.	1.15	.70	98.15
1450	Eclipse Russell & Co., Watkins.	.76	.47	98.77
817	Fancy Walter T. Olin, Perry.	.94	1.35	97.71
1472	G J. W. Matthews & Co., Newburgh.	.15	.35	99.50
522	Globe E. N. Dexter & Co., Morrisville.	.12	.25	99.63
1293	Globe James Faucett, Bath.	.20	.10	99.70
1301	Globe B. Frank Hull & Co., Gouverneur.	.05	.25	99.70
1287	Gold Avoca Hardware Co., Avoca.	.25	.15	99.60
531	Gold George B. Fletcher, Oxford.	.20	.25	99.55
841	Gold Harvey & Howes, Ionia.	.10	.47	99.43
1475	Gold Medal John H. Westermon, Walden.	.15	.17	99.68
1454	Honor Goshen Hardware Co., Goshen.	.25	.30	99.45
1354	Honor Wm. L. Potvin, Hudson Falls.	.13	.19	99.68
1284	Honor John W. Waters, Avoca.	.25	.22	99.53
1160	Honor C. Ray Harvey, Remsen.	.25	.05	99.70
815	Honor George C. Broadbooks, Attica.	.02	.30	99.68

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	TIMOTHY (*continued*):			
529	Honor French, Mead & Co., Oxford.	.10	.32	99.58
1033	Jap Burr & Starkweather Co., Rochester.	.19	.50	99.31
1451	Jap L. R. Wallace, Middletown.	.76	.85	98.39
1359	King A. V. Brayton, Glens Falls.	.15	.05	99.80
1273	King Shults Bros., Cohocton.	.55	.25	99.20
1159	King J. R. Drake, Boonville.	.50	.25	99.25
858	King Weldon F. Weston & Co., Beacon.	.40	.35	99.25
824	King J. H. Colgrove, Canaseraga.	.28	.19	99.53
1352	Liberty H. S. & J. S. Shippy, Hudson Falls.	.59	.50	98.91
1270	Liberty Frank Doty, Wayland.	.07	.19	99.74
1161	Liberty C. Ray Harvey, Remsen.	.15	.30	99.55
819	Liberty Joseph Ireland, Perry.	.04	.20	99.76
528	Liberty French, Mead & Co., Oxford.	.50	.32	99.18
667	Model Lucien C. Hatch & Son, Fallsburg.	.74	.95	98.31
520	Onondaga E. N. Dexter & Co., Morrisville.	.30	.27	99.43
849	Onondaga Fish, Burns & Fish, Alton.	.07	.30	99.63
1463	Pan American Recleaned Everett & Treadwell, Kingston.	.50	.45	99.05
1260	Pan American Recleaned Horton & Crosin, Penn Yan.	.28	.17	99.55
805	Pan American, Recleaned Perry C. Shafer Co., Brockport.	.47	.49	99.04
1465	Pine Tree Matthews & Harrison, Kingston.	.10	.10	99.80
1303	Pine Tree Norwood Feed & Supply Co., Norwood.	.15	.25	99.60
1295	Pine Tree Oscar T. Adsit, Corning.	.05	.50	99.45
1156	Pine Tree A. J. Schweinsberg, Boonville.	.30	.25	99.45
1017	Pine Tree Brewster, Crittenden & Co., Rochester.	.22	.25	99.53

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Percentage of inert matter.	Pure seed.
		Per ct.	*Per ct.*	*Per ct.*
	TIMOTHY (*continued*):			
925	Pine Tree The Forrest Seed Co., Inc., Cortland.	.10	.35	99.55
1253	Premier Maloney Bros., Waterloo.	.09	.12	99.79
857	Rex Weldon F. Weston & Co., Beacon.	.75	.55	98.70
1208	Safe Miller, Crozier & Co., Canisteo.	.25	.15	99.60
1555	Square Deal Hunt & Washburn, Delanson.	.50	.80	98.70
1420	Timothy Fred. L. Jennings, Elmira.	.60	.15	99.25
1016	Timothy Brewster, Crittenden & Co., Rochester.	.54	.30	99.16
1351	Timothy Edgar L. Potter, Fort Edward.	1.12	.80	99.08
832	Timothy Wm. Hamilton & Son, Caledonia.	.10	.25	99.65
1043	Timothy Joseph Fritts, Darien Center.	.72	.45	98.83
1459	Timothy Snyder Fancher Co., Middletown.	11.61	1.20	87.19
837	Winner L. G. De Muth, Darien.	.10	.30	99.60
	VETCH:			
1048	Hairy Winter Crosman Bros., Rochester.	.99	.25	98.76
843	Hairy Winter E. F. Dibble, Honeoye Falls.	1.27	.10	98.63
	ALSIKE AND WHITE CLOVER:			
1036	Fancy Burr & Starkweather Co., Rochester.	1.54	.35	98.11
	ALSIKE AND TIMOTHY:			
1292	Alsike and Timothy Geo. W. Peck Co., Bath.	4.22	3.40	92.38

METHOD OF ANALYSIS.

Assembly Bill No. 628 became a law (Chapter 59 of the Laws of 1914) with the Governor's signature on March 20, 1914. This bill amends Section 340 of the Agricultural Law in relation to seeds, and changes the method of determining the percentum of foul or foreign seed from " count " to " weight ". All of the seed samples collected during the season previous to March 20, 1914, were analyzed by the " count " method, *i. e.*, the regulation weight of sample was used and the seed impurities counted, as were also the crop seeds in the sample, and from these data the percentage of foul and foreign seed was determined by the proportional number of seeds in the sample.* All of the samples collected after March 20, 1914, were analyzed by the weight method, following as closely as possible the rules and regulations for seed testing as adopted by the Association of Official Seed Analysts.

REQUIREMENTS OF THE AGRICULTURAL SEED LAW.

The provisions of the agricultural seed law relative to the tag or label requirements are very simple and exceedingly lenient. It is merely required that every receptacle, package, sack or bag containing any of the designated agricultural seeds containing in excess of 3 per ct., by weight, of foul or foreign seeds shall be plainly marked or labeled with the percentage of such foul or foreign seed contained therein. No restriction is placed upon the amount of inert matter, such as broken seed, sticks, dirt, sand, chaff, etc., these agricultural seeds may contain. In other words, a lot of seed may contain a very low percentage of pure seed, the remaining percentage being inert matter and weed seeds, and still not require labeling if the percentage of foul or foreign seed does not exceed 3 per ct. by weight.

It is held that mixtures of seeds containing, as one of the principal component parts, any of the seeds named in the statute as agricultural seeds comes within the provisions of the statute, but the names of the seeds composing the mixture need not appear on the package. The package must be labeled with the percentage of foul or foreign seeds when the amount of such seeds exceeds 3 per ct. by weight.

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* For a more detailed discussion of the " count " method as applied in the determination of purity of seeds see Bulletins No. 362 and 378 of this Station.

DISCUSSION OF THE RESULTS OF THE INSPECTION OF SEEDS AND ITS SIGNIFICANCE TO NEW YORK FARMERS.

During the past year 303 official samples of seed were collected and analyzed. Of these, 33, or 10.9 per ct. were violations of the seed law; that is, they contained over 3 per ct. of foul or foreign seed and were not so labeled.

The fact that 20.8 per ct. of the samples collected during 1912 were violations of the seed law while there were 17.5 per ct. of violations in 1913, and only 10.9 per ct. in 1914 seems to indicate that the amount of misnamed seed or unlabeled seed of poor quality upon the market is decreasing.

The present seed law, however, affords only partial protection since it does not require a reasonable freedom from dodder or other noxious weed seeds, or a certain freedom from inert matter. Many of the most harmful or objectionable samples of seed passed the requirements of the law. Some of them were practically worthless for seeding purposes, but showed only about 1 per ct. of foreign seeds present. They contained large amounts of dodder and Canada thistle seed and considerable mustard seed, and some samples consisted mainly of brown, dead and shriveled seeds incapable of germination. In fact, our analyses showed 42 of the 303 samples to be composed mainly of brown, dead and shriveled seeds. Six of the red clover and alfalfa seed samples were badly infested with dodder. Two of the 303 samples contained bull thistle seed, 2 contained Canada thistle seeds and 5 contained considerable mustard seed, while 125 contained varying amounts of seeds of weeds classed as noxious, thereby making 57 of the samples questionable, 26 objectionable, and 3 absolutely worthless for seeding purposes. Twenty-three of the samples contained considerable amounts of chaff, and 10 samples were very dirty — being uncleaned seed. Several of the alfalfa samples gave evidence of being imported commercial Turkestan seed. Only 91 of the 303 samples were classified as good, others were regarded as only average in quality. In other words, the worthless and objectionable lots of seed passed onto the market unlabeled or without any warning as to their content of noxious weed seeds or other defects. It has been previously pointed out that the present seed law requires no reasonable freedom from dodder or other noxious weeds. The writer is in possession of evidence to the effect that in several cases dodder-laden alfalfa and red clover seed was shipped into this State from adjoining states and sold here because, owing to its excessive dodder content, it could not be legally placed on sale in those states.

It is therefore evident that the purchaser of seeds must, in the absence of any authentic statement concerning the nature and amount of the impurities present, rely upon his own ability to judge of the quality of the seeds he intends to purchase, or else have purity tests made of samples of the goods.

With a few exceptions, all of the samples which proved to be violations of the seed law were those of alsike clover seed containing more than 3 per ct. of the seeds of white clover and timothy, which did not constitute serious defects as far as seeding value was concerned. These seeds undoubtedly occurred in the alsike clover seed through natural infestation in the field, and because of their similar size, shape and weight, their removal was a practical impossibility.

Since the inception of the present seed law in this State the general practice of several of the best seedsmen selling goods within the state has been to label every lot of seed sold by them. Competent seed analysts have been employed for this purpose and a reputation for dependable seeds is the result of the practice. This fact should be borne in mind when labeled seeds are encountered in the market, since the use of labels may not in all cases indicate that the seeds sold under them require such identification to comply with the provisions of the seed law.

Purchasers of seeds may utilize the official reports to a certain extent as a guide to the character of the seed sold by some dealers, and the uniform grade or quality of some brands of seed. A summary of the analyses of brands of seed collected officially during the past three seasons shows that they are fairly uniform and in some cases represent the best grades of seed obtainable. However, brand names in the case of seeds may not have the value which they have in the case of some other commodities. Dealers often use the official reports as advertizing matter in selling their seeds, but in this connection it should be remembered that the reports upon samples for one season may be no indication of the quality of seed sold under the same name or by the same dealer during the following season.

II. VOLUNTARY EXAMINATIONS FOR CORRESPONDENTS.

During the past year, 1,155 samples of seed have been received from correspondents. The greater proportion of the samples were those of alfalfa, red clover, alsike clover and timothy. Many of the samples were entirely too small for a dependable analysis and some of them did not represent fairly the bulk from which they were drawn, that is, they were small packets of specially cleaned seed put up for advertizing purposes. Seed should not be bought by sample except in cases where the sample is drawn from the well-mixed bulk and is representative of the lot from which it is taken. Samples should be secured by taking small quantities from all of the bags, or from different parts of any bulk, and should weigh at least two ounces. Such seed samples should be accompanied by a time limit within which the dealer agrees to furnish the same seed in bulk.

THE PURITY REPORT.

When interpreting the purity report one should consider carefully the nature and amount of impurities found to be present in the sample, since the table of seed impurities which follows this discussion indicates that nearly all of our weeds are introduced upon the farm through crop seeds carelessly purchased. The reports made on samples sent in for testing are for private use only and are not to be used for advertizing purposes, since they are presumably accurate only for the sample submitted for examination and are not a guaranty of the lot from which the sample was taken. The Station will refuse to make tests for anyone who knowingly or persistently violates this regulation.

NUMBER OF TESTS AND FOR WHOM MADE.

The number of seed purity tests (1155) made voluntarily during the past year has exceeded that of any previous year. No tests have been made for seedsmen or seed dealers, since the Station cannot assume the burden of the analytical seed work for the trade.

The fact that Granges, Agricultural Societies, Farmers Cooperative Associations and Farm Bureau Managers have cooperated with the seed laboratory by sending in one sample from large lots of seed, which they purchased for their respective organizations, prevented the number of samples sent in for analysis from being materially larger. Numerous large shipments of desirable western-grown alfalfa seed have been secured by these organizations through one purity test made at this Station. Such a procedure is commendable since it prevents duplication of tests upon any one lot of seed, and extends the benefit to be derived from the seed laboratory to a larger number of farmers.

IMPORTED SEED.

The fact that 16.2 per ct. of the alfalfa samples examined contained the seeds of Russian knapweed (*Centaurea picris*) identifies such seed as imported commercial Turkestan seed.* Many other samples of alfalfa seed were suspected of being commercial Turkestan seed because of the grayish color of the seed due to a covering of finely divided clay characteristic of this seed. The Russian knapweed seeds in commercial Turkestan alfalfa seed are easily distinguished from those of alfalfa by their slightly larger size, wedge-shaped form and chalky-white color. Tests indicate that commercial Turkestan seed is decidedly inferior to the ordinary American variety in New York State. Such seed retails for a higher price than the common American variety.

SEED IMPURITIES.

Of the alfalfa seed samples examined in 1913, 11 per ct. contained seeds of dodder, while of those examined in 1914 only 6 per ct. contained dodder seeds, the reduction being mainly in small-seeded dodder, indicating the more frequent use of cleaning machinery. The number and variety of seed impurities, both foul and foreign, found in crop seeds for sale in this State appears to be gradually increasing, mainly by the addition of weeds new to New York State.

The following table gives a complete list of the foreign seeds or seed impurities found in samples analyzed during 1913 and 1914, with the number and kind of crop seed samples in which they were found:

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* For a complete discussion of commercial Turkestan alfalfa seed see Bulletin No. 138 of the U. S. Department of Agriculture, by Mr. E. M. Brown, Botanist in charge of the Seed Laboratory.

TABLE II.—FOREIGN SEEDS FOUND IN SEED SAMPLES AND THE NUMBER AND KIND OF SAMPLES IN WHICH THEY OCCURRED.

NAMES OF SEED IMPURITIES.	KIND OF CROP SEED.									
	Alfalfa.	Red clover.	Timothy.	Alsike clover.	Alsike and timothy mixture.	Redtop.	Hairy vetch.	White clover.	Kentucky blue grass.	Miscellaneous samples.
Number of samples examined	628	485	358	452	64	17	14	11	12	89
Aizoaceae, spp	1	...	...	...	...	...	...	...	...	...
Alfalfa (*Medicago sativa* L.)	...	7	6	21	3	...	...	2	...	6
Alfilaria (*Erodium cicutarium* (L.) L'Her.)	...	1	...	...	...	...	...	...	...	...
Alsike clover (*Trifolium hybridum* L.)	66	239	222	...	...	3	...	7	1	9
Arkansas rose (*Rosa* spp.)	...	...	...	...	...	...	...	...	...	1
Ax seed (*Coronilla scoparioides* Koch.)	...	3	...	...	...	...	...	...	...	3
Axyris amaranthoides	1	...	...	...	...	...	...	...	...	...
Barnyard grass (*Echinochloa crus-galli* (L.) Beauv.)	67	35	...	...	2	...	...	...	...	2
Bermuda grass (*Cynodon dactylon* L.)	...	...	...	...	...	...	...	...	...	1
Bindweed, great (*Convolvulus sepium* L.)	14	...	...	...	...	...	...	...	...	...
Bird's-foot trefoil (*Lotus corniculatus* L.)	10	2	...	...	...	...	...	1	...	2
Black-eyed Susan (*Rudbeckia hirta* L.)	...	...	28	...	4	4	...	...	...	1
Black medick (*Medicago lupulina L.*)	8	6	6	173	12	...	...	...	...	3
Bladder ketmia (*Hibiscus trionum* L.)	2	...	...	...	...	...	...	...	...	...
Blue field madder (*Sherardia arvensis* L.)	4	4	...	...	...	...	...	1	...	2
Blue grass (*Poa* spp.)	24	11	141	56	28	...	...	3	2	11
Bull thistle (*Cirsium lanceolatum* (L.) Hill)	3	15	...	...	...	...	...	...	...	2
Burdock (*Arctium minus* Bernh.)	3	1	...	...	...	...	...	...	...	1
Buttercup (*Ranunculus bulbosus* L.)	...	...	1	...	...	...	...	...	...	4
Buttercup, bitter (*Ranunculus acris* L.)	...	...	...	1	...	...	...	...	...	...
Campion, bladder (*Silene latifolia* (Mill) B. & R.)	1	...	...	...	...	...	...	...	...	...
Campion, white (*Lychnis alba* Mill.)	...	...	...	...	...	...	...	...	...	2
Campion, red (*Lychnis dioica* L.)	...	1	...	...	...	...	...	...	...	...
Canada thistle (*Cirsium arvense* (L.) Scop.)	3	21	23	38	7	...	...	...	1	4
Canary grass (*Phalaris canariensis* L.)	...	...	...	...	...	...	...	...	...	1
Catchfly, night flowering (*Silene noctiflora* L.)	8	30	6	64	5	...	...	3	...	3
Catchfly, sleepy (*Silene antirrhina* L.)	...	1	2	...	...	...	...	...	...	...
Catchfly, forked (*Silene dichotoma* Ehrh. L.)	...	1	...	1	...	...	...	1	...	...
Catnip (*Nepeta cataria* L.)	...	18	15	7	6	...	...	...	...	2
Chess; cheat (*Bromus secalinus* L.)	...	4	...	1	...	...	...	...	...	2
Chickweed (*Stellaria media* (L.) Cyrill.)	...	1	1	12	...	1	...	3	...	...
Chickweed, mouse eared (*Cerastium vulgatum* L.)	3	4	32	102	22	3	...	4	4	8
Chicory (*Cichorium intybus* L.)	69	16	7	2	1	...	...	...	...	...
Cinquefoil (*Potentilla canadensis* L.)	...	...	4	...	...	...	...	...	...	2
Cinquefoil (*Potentilla monspeliensis* L.)	2	3	89	18	15	3	...	...	1	5
Cinquefoil, silvery (*Potentilla argentea* L.)	...	...	3	...	...	...	...	...	...	...

TABLE II (*continued*).

NAMES OF SEED IMPURITIES.	KIND OF CROP SEED.									
	Alfalfa.	Red clover.	Timothy.	Alsike clover.	Alsike and timothy mixture.	Redtop.	Hairy vetch.	White clover.	Kentucky blue grass.	Miscellaneous samples.
Cleavers (*Galium* spp.)							5			3
Cockle (*Agrostemma githago* L.)	1			1			12			2
Compositae, spp	4		1							
Corn chamomile (*Anthemis arvensis* L.)		7	15	47	8			5		1
Cow herb (*Saponaria vaccaria* L.)										1
Crab-grass, small (*Digitaria humifusa* Pers.)	1	54	4	3				1		3
Crab-grass, large (*Digitaria sanguinalis* L.)	3	7			2					2
Cranesbill (*Geranium* spp.)		1								
Cranesbill (*Geranium dissectum* L.)	1	7								3
Cranesbill (*Geranium pusilum* Burm.)								1		
Creeping thyme (*Thymus serpyllum* L.)						1				
Crimson clover (*Trifolium incarnatum* L.)	2	1								1
Dandelion (*Taraxacum erythrospermum* Andrz.)	1	2		1						
Darnel (*Lolium multiflorum* Lam.)										1
Dead nettle (*Lamium amplexicaule* L.)			1							
Dock, bitter (*Rumex otusifolius* L.)	1									
Dock, curled (*Rumex crispus* L.)	59	168	32	135	24				1	16
Dock (*Rumex* spp.)	11	38	6	12						3
Dodder, clover (*Cuscuta epithymum* Murr.)	15	3								
Dodder, field (*Cuscuta arvensis* Beyrich.)	39									
Dogs-tail grass (*Cynosurus cristatus* L.)										1
Dragon head (*Dracocephalum parviflorum* Nutt.)		1								
Ergot (Sclerotia) (*Claviceps* sp.)			26			3				2
Evening primrose (*Onagra biennis* (L.) Scop.)			18	2	1					2
False flax (*Camelina microcarpa* Andrz.)	6		16	23	5					4
False flax (*Camelina sativa* (L.) Crantz.)	3			5						4
Fireweed *Erechtites hieracifolia* (L.) Raf.)		1		1	1					
Flax (*Linum usitatissimum* L.)	6									2
Fleabane, annual (*Erigeron annuus* (L.)Pers.)										1
Forget-me-not (*Myostis*, spp.)	1	1	2					1		
Foxtail, green (*Chaetochloa viridis* (L.) Nash.)	376	263	18	35	7			1		13
Foxtail, yellow (*Chaetochloa glauca* (L.) Scrib.)	59	24		3						8
Furze, (*Ulex europaeus* L.)	1									
Galium sp	1		8				1			
Grass (*Poaceae* spp.)	31	27	7	9	4	1		1		10
Gum plant (*Grindelia* squarrosa (Pursh.) Dunal)	3	3								
Hare's ear (*Conringia orientalis* (L.) Dumort)		1								1

TABLE II (*continued*).

NAMES OF SEED IMPURITIES.	KIND OF CROP SEED.									
	Alfalfa.	Red clover.	Timothy.	Alsike clover.	Alsike and timothy mixture.	Redtop.	Hairy vetch.	White clover.	Kentucky blue grass.	Miscellaneous samples.
Heal-all (*Prunella vulgaris* L.)	6	35	15	22	3	1	...	2	...	1
Hoary alyssum (*Alyssum alyssoides* L.)	...	...	1	...	...	...	...	...	...	...
Hoary cress (*Lepidium draba* L.)	6	...	...	...	...	...	...	...	...	...
Horse weed (Erigeron canadensis L.)	...	...	1	...	...	3	...	...	...	...
Johnson grass (*Sorghum halepense* (L.) Pers.)	48	1	1	...	...	...	...	...	...	2
Knapweed (*Centaurea nigra* L.)	...	...	...	...	...	...	...	1	...	2
Knot grass (*Polygonum aviculare* L.)	54	17	2	3	2	...	...	...	...	3
Knotweed, erect (*Polygonum erectum* L.)	...	1	...	...	...	...	...	...	...	...
Lady's thumb (*Polygonum persicaria* L.)	7	156	7	3	1	...	...	...	...	8
Lamb's quarters (*Chenopodium album* L.)	156	115	47	21	7	...	...	4	...	20
Leguminosae spp	2	1	...	...	...	...	...	...	...	1
Lentil (*Ervum lens* L.)	1	1	...	...	...	...	...	...	...	...
Mallow (*Malva rotundifolia* L.)	13	4	...	...	...	...	...	...	...	1
Mallow, whorled (*Malva verticillata* L.)	3	1	...	...	...	...	...	...	...	...
Malva sp	1	...	...	...	...	...	...	...	...	...
Maple-leaved goose foot (*Chenopodium hybridum* L.)	1	...	...	...	...	...	...	...	...	...
Marsh elder (*Iva xanthifolia* (Fresn.) Nutt.)	21	...	...	...	...	...	...	...	...	...
May weed (*Anthemis cotula* L.)	...	15	15	13	1	1	...	...	...	1
Meadow fescue (*Festuca elatior* L.)	1	...	...	...	...	...	...	...	...	...
Meadow foxtail (*Alopecurus pratensis* L.)	...	...	...	...	...	...	...	...	...	1
Mignonette (*Reseda* spp.)	...	...	...	...	...	...	...	...	...	1
Milkweed (*Asclepias syriaca* L.)	1	...	...	...	...	...	...	...	...	...
Millet (*Chaetochloa italica* (L.) Beauv.)	28	4	1	...	...	...	...	...	1	4
Motherwort (*Leonurus cardiaca* L.)	...	2	1	...	1	...	...	...	...	...
Mullen (*Verbascum* spp.)	...	...	1	1	...	...	...	...	...	...
Mustard (*Brassica* spp.)	40	7	1	6	...	...	...	...	...	14
Mustard, treacle (*Erysimum cheiranthoides* L.)	...	1	5	3	1	2	...	1	...	2
Narrow-leaved hawk's-beard (*Crepis tectorum* L.)	...	...	...	...	...	...	...	...	...	1
Niger seed (*Guizotia abyssinica* Cass.)	2	5	...	...	...	...	...	...	...	...
Nipplewort (*Lapsana communis* L.)	1	...	1	2	1	...	...	...	...	...
Old witch grass (*Panicum capillare* L.)	20	18	3	3	...	4	...	...	1	5
Orchard grass (*Dactylis glomerata* L.)	1	...	3	...	...	...	...	...	...	...
Ovoid spike rush (*Eleocharis ovata* (Roth.) R. & S.)	1	1	...	...	...	...	...	...	...	1
Oxeye daisy (*Chrysanthemum leucanthemum* L.)	1	4	33	95	23	...	...	...	...	5
Pale persicaria (*Polygonum lapathifolium* L.)	...	...	...	...	...	...	...	...	...	1
Panicum lanuginosum Ell.)	...	...	1	...	...	...	...	...	...	...

TABLE II (*continued*).

NAMES OF SEED IMPURITIES.	KIND OF CROP SEED.									
	Alfalfa.	Red clover.	Timothy.	Alsike clover.	Alsike and timothy mixture.	Redtop.	Hairy vetch.	White clover.	Kentucky blue grass.	Miscellaneous samples.
Paspalum (*Paspalum setaceum* Michx.)	17	4	...	...	...	...	...	...	...	1
Penny cress (*Thlaspi arvense* L.)	...	...	...	1	...	...	...	...	...	2
Penn. persicaria (*Polygonum pennsylvanicum* L.)	...	1	...	...	...	...	...	...	...	...
Peppergrass, apetalous (*Lepidium apetalum* (L.) R. Br.)	...	...	...	2	1	...	...	...	...	...
Pepper-grass (*Lepidium campestre* (L.) R. Br.)	1	9	3	27	4	...	...	...	...	3
Pepper-grass, wild (*Lepidium virginicum* L.)	3	6	172	25	13	5	...	2	6	17
Picris (*Picris hieracioides* L.)	2	1	...	...	...	...	...	...	...	...
Picris; oxtongue (*Picris echioides* L.)	6	3	...	...	...	...	...	...	...	...
Pigweed (*Amaranthus* spp.)	56	19	17	3	...	...	...	...	...	6
Pigweed (*Amaranthus blitoides* S. Wats.)	45	1	2	2	...	...	...	...	...	1
Pigweed; tumbleweed (*Amaranthus graecizans* L.)	23	15	4	1	1	...	...	...	...	1
Pigweed, slender (*Amaranthus hybridus* L.)	2	...	1	...	1	...	...	...	...	...
Pigweed, rough (*Amaranthus retroflexus* L.)	19	5	4	4	2	...	...	...	...	1
Pigweed, winged (*Cycloloma atriplicifolium* (Spreng.) Coulter)	1	...	...	...	...	...	...	...	...	...
Plantain (*Plantago rhodosperma* L.)	...	...	...	...	...	...	...	...	...	1
Plantain, buckhorn (*Plantago lanceolata* L.)	106	301	52	247	42	...	...	6	...	15
Plantain, Rugels (*Plantago rugelii* Decne.)	6	202	187	24	15	8	...	2	...	10
Plantain, broad-leaved (*Plantago major* L.)	...	9	5	2	2	1	...	...	...	...
Plantain, large-bracted (*Plantago aristata* Michx.)	1	21	2	...	...	...	...	1	...	2
Poison hemlock (*Conium maculatum* L.)	4	2	...	...	...	...	...	...	...	1
Poppy (*Glaucium* spp.)	2	1	1	...	...	...	...	...	...	...
Poverty weed (*Iva axillaris* Pursh.)	2	...	...	...	...	...	...	...	...	...
Prickly Sida (*Sida spinosa* L.)	...	1	...	...	...	...	...	...	...	...
Purslane; Pussley (*Portulaca oleracea* L.)	...	...	1	...	...	...	...	...	...	...
Quack grass (*Agropyron repens* (L.) Beauv.)	1	...	2	...	...	...	...	...	...	2
Ragweed (*Ambrosia artemisiifolia* L.)	4	62	...	...	...	...	...	...	...	4
Red clover (*Trifolium pratense* L.)	115	...	82	195	22	...	...	...	...	9
Redtop (*Agrostis alba* L.)	20	4	110	24	17	...	...	4	...	8
Roquette (*Eruca sativa* Mill.)	25	...	2	...	...	...	...	...	...	...
Rush (*Juncus tenuis* Willd.)	...	...	2	...	1	6	...	...	...	3
Rush, Wood (*Juncoides nemorosum* (Poll.) Mey.)	...	...	...	...	...	...	...	...	...	1
Russian knapweed (*Centaurea picris* L.)	102	...	...	...	...	...	...	...	...	...
Russian thistle (*Salsola kali tenuifolia* G. F. W. Mey.)	87	5	...	1	...	...	...	...	...	1
Rutabaga (*Brassica campestris* L.)	...	1	...	...	...	...	...	...	...	...

TABLE II (*continued*).

NAMES OF SEED IMPURITIES.	KIND OF CROP SEED.									
	Alfalfa.	Red clover.	Timothy.	Alsike clover.	Alsike and timothy mixture.	Redtop.	Hairy vetch.	White clover.	Kentucky blue grass.	Miscellaneous samples.
Rye (*Secale cereale* L.)	1						1			
Rye grass, English (*Lolium perenne* L.)								1		2
Rye grass, Italian (*Lolium italicum*)										2
Sage, lance-leaved (*Salvia lanceaefolia* Poir.)	7			1						1
Sage, lyre-leaved (*Salvia lyrata* L.)	1									
Salt bush; Orache (*Atriplex patula* L.)	17	1								
Sand bur (*Cenchrus tribuloides* L.)	2			1						
Sand rocket (*Diplotaxis muralis* (L.) DC.)	1		8	17						3
Sandwort, thyme l'v'd (*Arenaria serpyllifolia* L.)			2	1		1				
Sedge (*Carex* spp.)		2	42	6	9	11			8	13
Sesium moriantalea L.										1
Sheep sorrel (*Rumex acetosella* L.)	6	131	103	189	25	5		8	3	21
Shepherd's purse (*Capsella bursa-pastoris* (L.) Medic.)			7	3	3	1			2	1
Slender nettle (*Urtica gracilis* Ait.)				2	1					
Smart-weed (*Polygonum hydropiper* L.)	1	2	1	1						
Spring vetch (*Vicia sativa* L.)							12			
Spurry (*Spergula arvensis* L.)			1					2		
St. John's wort (*Hypericum perforatum* L.)			1							
Star thistle (*Centaurea cyanus* L.)	1									
Star thistle (*Centaurea jacea* L.)	1									
Star thistle (*Centaurea* spp.)	3	2								3
Star thistle (*Centaurea solstitialis* L.)		3								1
Sow thistle (*Sonchus asper* L.)					1					
Spike grass (*Uniola latifolia* Michx.)	1									
Spurge (*Euphorbia* spp. L.)		3								
Spurge, thyme-l'v'd (*Euphorbia serpyllifolia* Pers.)	2	6		2						1
Spurge, upright spotted (*Euphorbia preslii* Guss.)	3	11								3
Stick-seed (*Lappula echinata* Gilibert)	3	1								3
Stink-grass (*Eragrostis megastachya* Link.)			1							
Sweet clover, white *Melilotus alba* Desr.)	30	4		1	2					2
Sweet clover, yellow (*Melilotus officinalis* (L.) Lam.)	2									
Sweet vernal grass (*Anthoxanthum odoratum* L.)										1
Switch grass (*Panicum virgatum* L.)	1									1
Tearthumb (*Polygonum sagittatum* L.)	1									
Thorough wax (*Bupleurum rotundifolium* L.)		1								

TABLE II (*concluded*).

NAMES OF SEED IMPURITIES.	KIND OF CROP SEED.									
	Alfalfa.	Red clover.	Timothy.	Alsike clover.	Alsike and timothy mixture.	Redtop.	Hairy vetch.	White clover.	Kentucky blue grass.	Miscellaneous samples.
Thorough wax (*Bupleurum protractum* L.)	...	2	...	...	...	...	...	...	...	...
Three-seeded mercury (*Acalypha Virginica* L.)	2	14	...	...	...	...	...	...	...	...
Timothy (*Phleum pratense* L.)	105	153	...	372	...	11	...	5	1	13
Trifolium bifidum	...	1	...	...	...	...	...	...	...	...
Trifolium dubium Sibth	...	...	...	...	...	...	...	1	...	...
Trifolium procumbens	1	2	1	5	...	...	...	2	...	2
Trianthema monogyna L	6	...	...	...	...	...	...	...	...	...
Unidentified	9	2	4	3	1	...	...	3	...	...
Valerianella spp	1	...	...	...	...	...	...	...	...	...
Vervain, blue (*Verbena hastata* L.)	2	6	19	...	1	2	...	...	...	1
Vicia spp	1	...	...	...	...	...	2	...	...	...
Viola spp	...	...	...	...	...	...	...	1	...	...
Wheat thief (*Lithospermum arvense* L.)	2	1	...	...	...	...	...	...	...	4
White clover (*Trifolium repens* L.)	9	11	111	281	24	4	...	...	2	8
White hoarhound (*Marrubium vulgare* L.)	1	...	3	12	6	...	...	...	...	...
Wild buckwheat (*Polygonum convolvulus* L.)	8	1	...	...	...	...	...	...	...	1
Wild carrot (*Daucus carota* L.)	7	50	8	4	...	...	...	1	...	2
Wild lettuce (*Lactuca canadensis* L.)	2	...	1	1	1	...	...	...	...	...
Wild oats (*Avena fatua* L.)	...	...	...	...	...	...	...	...	...	1
Wild radish (*Raphanus raphanistrum* L.)	1	2	...	...	...	...	...	...	...	2
Wild sunflower (*Helianthus annuus* L.)	4	...	...	...	...	...	...	...	...	3
Wild vetch (*Lotus americanus* (Nutt.) Bisch.)	...	...	...	...	...	...	3	...	...	2
Willow herb (*Epilobium adenocaulon* L.)	...	...	1	...	...	1	...	...	...	...
Willow herb (*Epilobium paniculatum* L.)	...	...	1	...	...	1	...	...	...	...
Wood sage (*Teucrium canadense* L.)	...	...	...	...	1	...	...	...	...	...
Yarrow (*Achillea millefolium* L.)	...	...	5	3	...	8	...	...	...	1
Yellow rocket (*Barbarea barbarea* (L.) MacM.)	1	2	22	94	1	...	...	1	...	3

INSPECTION OF FEEDING STUFFS.†

This bulletin gives the results of the analyses[1] of samples of feeding stuffs collected by the Commissioner of Agriculture during the fall and winter of 1914–15 and by him transmitted for analysis to the Director of the New York Agricultural Experiment Station, in accordance with the provisions of Article VII of the Agricultural Law. These analyses are published by the Director of the New York Agricultural Experiment Station in accordance with the provisions of section 164 of said article.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	COTTONSEED MEALS:		*Per ct.*	*Per ct.*	*Per ct.*
7160	The American Cotton Oil Co., Trenton, Tenn. "Red Tag Cotton Seed Meal"	Brewster	G* 38.55 F* 38.8	7. 7.2	11.50 10.1
5734	M. F. Baringer, Philadelphia, Pa. "Special Cotton Seed Meal"	Utica	G 36. F 36.5	6. 6.8	16. 12.8
7053	M. F. Baringer, Philadelphia, Pa. "M. F. B. Prime Cottonseed Meal"	Delhi	G 38.62 F 38.6	6. 7.7	12. 9.9
7755	The J. E. Bartlett Co., Jackson, Mich. "Michigan Farmer Brand Cotton Seed Meal"	Hannibal	G 41. F 41.6	7. 7.2	10. 7.5
6150	F. W. Brode & Co., Memphis, Tenn. "Owl Brand High Grade Cotton Seed Meal"	Owego	G 41. F 42.6	6. 7.7	10. 7.1
6904	F. W. Brode & Co., Memphis, Tenn. "Owl Brand High Grade Cotton Seed Meal"	Poughkeepsie	G 41. F 41.	6. 8.4	10. 8.5
7063	F. W. Brode & Co., Memphis, Tenn. "Owl Brand High Grade Cotton Seed Meal"	Fleischmann	G 41. F 40.5	6. 7.3	10. 9.9

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* These letters indicate, respectively, Guaranteed and Found.

[1] The analyses herewith published were made in charge of the Chemical Department of the Station, the immediate oversight of the work being assigned to Arthur W. Clark, Associate Chemist.

† A reprint of Bulletin No. 404, April, 1915.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	COTTONSEED MEALS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*
7209	F. W. Brode & Co., Memphis, Tenn. " Dove Brand Prime Cotton Seed Meal "	Ballston	G* 38.63 F* 38.6	6. 7.9	10. 9.5
6858	The Buckeye Cotton Oil Co., Cincinnati, O. " Buckeye Prime Cotton Seed Meal "	Norwich	G 38.62 F 39.9	6. 6.6	12. 9.9
7455	Chapin & Co., Inc., Hammond, Ind. " Green Diamond Brand Choice Cotton Seed Meal "	Scottsville	G 41. F 42.	7. 7.6	10. 8.2
7758	S. P. Davis, Little Rock, Ark. " Good Luck Brand Cotton Seed Meal "	Williamstown	G 41. F 41.2	7. 7.8	10.50 8.4
7767	H. J. Haslehurst, Baltimore, Md. " Oriole Brand Choice Cotton Seed Meal "	Oneonta	G 41. F 41.4	6. 8.8	10. 9.9
5868	D. H. Hicks & Company Memphis, Tenn. " Canary Brand Choice Cotton Seed Meal "	Tupper Lake	G 41. F 43.8	6. 7.7	10. 8.3
6924	Humphreys, Godwin Co., Memphis, Tenn. " Dixie Brand Cotton Seed Meal "	Poughkeepsie	G 38.62 F 40.1	6. 7.7	12. 10.
7352	Imperial Cotto Milling Co., Memphis, Tenn. " Imperial Cotto Brand Choice Cotton Seed Meal "	Winthrop	G 41. F 41.3	8. 9.5	9. 6.8
7431	Kemper Mill and Elevator Co., Kansas City, Mo. "Anchor Brand Choice Cotton Seed Meal "	Spencerport	G 41. F 39.5.	7.50 8.1	10. 7.1
7499	W. C. Nothern, Little Rock, Ark. " Bee Brand Cotton Seed Cake Meal "	Castile	G 41. F 44.	6. 7.6	10. 9.
8007	Geo. B. Robinson, Jr., New York, N. Y. " Cotton Seed Meal "	Brooklyn	G 38.55 F 41.4	6. 7.4	10. 7.8

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* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	COTTONSEED MEALS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
6769	W. Newton Smith, Baltimore, Md. " Dirigo Brand Cotton Seed Meal "	Corning	G* 41. F* 37.9	7. 9.1	10.50 10.1
7413	J. E. Soper Co., Boston, Mass. " Pioneer Cotton Seed Meal "	Warsaw	G 41. F 41.4	7. 7.3	10. 9.7
7105	Southern Cotton Oil Co., Charlotte, N. C. "Aurora Brand Cotton Meal"	Walton	G 41. F 41.8	7. 7.9	10. 7.9
7765	Traders & Producers Supply Co., Buffalo, N. Y. " Chippewa Choice Cotton Seed Meal "	Edmeston	G 41. F 40.6	7.50 6.8	14. 9.9
7103	Union Seed & Fertilizer Co., Huntsville, Ala. " American Red Tag Cotton Seed Meal "	Walton	G 38.55 F 40.5	7. 7.4	11.50 8.2
6349	Not given	Clarkson	G —— F 41.	—— 7.1	—— 12.2
	LINSEED MEALS:				
6276	American Milling Co., Peoria, Ill. " Amco Old Process Linseed Meal "	Syracuse	G 30. F 32.1	5. 7.1	10. 7.7
6612	American Milling Co., Peoria, Ill. " Amco Old Process Linseed Meal "	Fort Edward	G 32. F 32.6	6. 8.1	11. 8.3
7071	American Milling Co., Peoria, Ill. " Amco Old Process Linseed Meal " [1]	Delhi	G 30. F 30.7	5. 7.	10. 8.5
6985	American Linseed Co., New York, N. Y. " Hypro Pure Linseed Meal "	Binghamton	G 36. F 37.4	2. 3.3	9. 8.9
6883	American Linseed Co., Chicago, Ill. " Linseed Oil Meal "	New Woodstock	G 36. F 36.2	2. 3.3	9. 7.9
6863	American Linseed Co., New York, N. Y. " Old Process Oil Meal "	Sherburne	G 34. F 35.3	5. 5.5	8. 7.9

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* These letters indicate, respectively, Guaranteed and Found.

[1] Contains a small amount of ground weed seeds, chiefly wild buckwheat.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	LINSEED MEALS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
6962	Archer-Daniels Linseed Co.,		G* 32.	6.	10.
	Minneapolis, Minn.	McGrawville	F* 35.2	6.8	7.5
	" Old Process Ground Oil Cake "				
6905	Kelloggs & Miller,		G 32.	4.	9.
	Amsterdam, N. Y.	Poughkeepsie	F 37.4	6.5	7.6
	" Pure Old Process Oil Meal "				
6894	The Mann Bros. Co.,		G 34.	6.	10.
	Buffalo, N. Y.	Manlius	F 35.4	7.4	7.
	" Pure Old Process Linseed Oil Meal "				
7022	Minnesota Linseed Oil Co.,		G 34.	5.	11.
	Minneapolis, Minn.	No. Brookfield	F 36.6	7.2	6.7
	" Ground Old Process Linseed Cake "				
6969	The Toledo Seed & Oil Co.,		G 30.	5.	10.
	Toledo, O.	Binghamton	F 31.2	6.7	8.7
	" Major Brand Old Process Oil Meal "				
	MALT SPROUTS:				
5573	American Malting Co.,		G 10.32	1.30	24.40
	New York, N. Y.	New York City	F 16.5	1.5	16.8
	" Hully Malt Sprouts "[1]				
5806	American Malting Co.,		G 24.15	1.82	14.05
	Buffalo, N. Y.	McLean	F 27.6	1.3	11.7
	"No. 1 Malt Sprouts "				
5572	American Malting Co.,		G 19.42	1.76	16.40
	New York, N. Y.	New York City	F 27.4	1.5	9.4
	" Standard Malt Sprouts "[2]				
6482	Atlantic Export Co. of Wis.,		G 22.	1.	16.
	Chicago, Ill.	Albany	F 26.7	1.5	12.4
	" Malt Sprouts "				
7440	Bartholomay Brewery Co.,		G 21.	2.26	18.91
	Rochester, N. Y.	Rochester	F 25.8	1.7	11.9
	" Malt Sprouts "[3]				
7247	Farmers Feed Co.,		G 26.06	1.57	12.95
	New York, N. Y.	Monroe	F 29.6	1.6	13.4
	"Malt Sprouts "				

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* These letters indicate, respectively, Guaranteed and Found.

[1] Malt screenings consisting largely of barley hulls and malt sprouts.

[2] Contains broken pieces of malted barley and a small amount of barley hulls.

[3] Contains 7.1 per ct. of barley hulls.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	MALT SPROUTS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
7509	Lembeck & Bets, Eagle Brewing & Malting Co., Watkins, N. Y. "Malt Sprouts"	Watkins	G* 28.30 F* 29.9	1.12 1.7	13.31 10.5
6227	C. H. McLaughlin, Waterloo, N. Y. "Malt Sprouts"	Waterloo	G 26.30 F 28.1	2.45 2.2	10.49 9.4
6495	Geo. J. Meyer Malting Co., Buffalo, N. Y. "Malt Sprouts"	Watervliet	G 20.82 F 28.9	1.4 2.	14. 11.4
7452	Henry C. Moffat, Buffalo, N. Y. "Malt Sprouts" [1]	Churchville	G 20. F 24.9	1. 1.7	15. 10.3
5691	Perot Malting Co., Buffalo, N. Y. "Malt Sprouts" [2]	Walton	G 22. F 27.2	.50 1.3	18. 12.7
6658	M. G. Rankin & Co., Milwaukee, Wis. "Jersey Malt Sprouts" [3]	Waterville	G 25. F 25.4	1.50 1.8	17. 12.1
6983	Albert Schwill & Co., Buffalo, N. Y. "Malt Sprouts"	Binghamton	G 23.70 F 27.8	1. 1.2	14. 11.4
5298	C. U. Snyder & Co., Chicago, Ill. "Kleinco Malt Sprouts" [4]	Oxford	G 20. F 25.	2. 1.6	16. 12.9
6342	William Taylor, Clyde, N. Y. "Malt Sprouts"	Clyde	G —— F 24.6	—— 1.7	—— 13.
7501	Waterloo Malting Co., Waterloo, N. Y. "Malt Sprouts"	Waterloo	G 25.50 F 29.9	2.35 1.9	10.49 9.3
7283	The Zwickel Malting Co., Buffalo, N. Y. "Malt Sprouts" [5]	Buffalo	G 22. F 23.4	1. 2.	20. 12.1

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* These letters indicate, respectively, Guaranteed and Found.

[1] Contains a small amount of weed seeds.

[2] Guaranteed as containing a small percentage of wild seeds, grain and hulls; found to contain barley hulls and a trace of weed seeds.

[3] Contains small amount of barley hulls.

[4] Guaranteed as barley product for mixing purposes only; found to be malt sprouts containing malted barley and barley hulls.

[5] Guaranteed to contain small percentage of weed seeds and screenings; found to contain malted barley, barley hulls and a small amount of weed seeds.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	DISTILLED DRIED GRAINS:		*Per ct.*	*Per ct.*	*Per ct.*
6914	Ajax Milling & Feed Co., New York, N. Y. "Ajax Flakes"[1]	Poughkeepsie	G* 30 F* 31.2	11. 12.5	14. 10.6
7220	Atlantic Export Co. of Wis., Chicago, Ill. "Atlantic Grains"[2]	Granville	G 28. F 30.4	8. 9.7	13. 8.6
6888	Geo. E. Brisbin & Co., Clyde, N. Y. "Argood Dried Distillery Grains"[3]	Skaneateles	G 26. F 27.7	9. 11.3	12. 6.5
6880	Clarke Bros. & Co., Peoria, Ill. "Empire State Dairy Feed"[3]	New Woodstock	G 30. F 29.9	12. 10.2	12. 9.7
5674	Continental Cereal Company, Peoria, Ill. "Continental Gluten Feed"[3]	Stamford	G 29. F 27.	12.5 10.	10.5 6.9
7419	Continental Cereal Co., Peoria, Ill. "Continental Gluten Feed"[3]	Perry	G 29. F 30.6	10.5 8.7	10.5 6.
6982	The Dewey Bros. Co., Blanchester, O. "Bourbon 3 D Grains"[3]	De Ruyter	G 24. F 25.2	8. 8.	14. 9.9
5272	The Dewey Bros. Co., Blanchester, O. "Buckeye Feed"[4]	De Ruyter	G 20. F 20.2	5. 4.4	15. 10.8
7051	The Dewey Bros. Co., Manchester, O. "Corn 3 D Grains"[5]	Hamden	G 26. F 25.7	9. 11.2	13. 7.2
6872	The Dewey Bros. Co., Blanchester, O "Eagle 3 D Grains"[3]	Hamilton	G 30. F 32.7	10. 11.9	13. 8.
7167	The Dewey Bros. Co., Blanchester, O. "Queen 3 D Grains"[6]	Pawling	G 18. F 14.6	4. 7.1	15. 12.6

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[*] These letters indicate, respectively, Guaranteed and Found.

[1] Guaranteed as corn distillers' grains; found to be distillers' dried grains from corn, oats, barley and rye.

[2] Distillers' dried grains from corn, rye, barley and oats.

[3] Distillers' dried grains from corn, oats, rye and barley.

[4] Distillers' dried grains (largely rye), from rye, oats, barley and corn.

[5] Distillers' dried grains from corn, oats and barley.

[6] Distillers' dried grains, largely rye, from rye, oats and barley.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	DISTILLED DRIED GRAINS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
6881	The Hottelet Co., Milwaukee, Wis. "Hector Distillers Dried Grains"[1]	New Woodstock	G* 30. F* 32.2	10. 9.3	14. 13.3
7351	Hottelet & Co., Milwaukee, Wis. "XX" Distillers Dried Grains"[2]	Massena	G 18. F 18.1	6. 8.1	14. 10.1
6977	The Larrowe Milling Co., Detroit, Mich. "Brownie Grains, Steam-Dried Distillers Grains"[3]	Preble	G 26. F 27.5	7. 10.2	9. 6.5
7420	Merchants Distilling Co., Terre Haute, Ind. "Merchants High Grade Dairy Feed"[4]	Perry	G 30. F 30.6	11. 12.1	14. 8.3
6953	New York & Kentucky Co., Rochester, N. Y. "Columbia Corn Distillers Grains"[4]	Tully	G 30. F 30.7	10. 10.	14. 10.7
6980	The New York & Kentucky Co., Rochester, N. Y. "Pure Rye Distillers Grains"[2]	Marathon	G 14. F 16.5	6. 9.9	14. 11.5
6857	The Ubiko Milling Co., Cincinnati, O. "Fourex Distillers Dried Grains"[4]	Norwich	G 31. F 33.6	12. 13.4	13. 10.2
6348	Not given[4]	Clarkson	G — F 28.3	— 13.	— 10.
	DRIED GRAINS (Probably from manufacture of yeast, vinegar and whiskey)				
5299	M. F. Baringer, Philadelphia, Pa. "Atlantic Grains, Distillers Dried Grains"[5]	Sherburne	G 18. F 19.5	5.5 7.3	25. 16.
5300	Donahue-Stratton Co., Milwaukee, Wis. "'Onyx' Dried Grains"	Sherburne	G 20. F 19.6	6. 6.9	16. 15.9
	BREWERS' DRIED GRAINS:				
6950	Anheuser-Busch Brewing Ass'n., St. Louis, Mo. "Dried Brewers Grains"	Poughkeepsie	G 21. F 26.7	6. 7.8	18. 13.5

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* These letters indicate, respectively, Guaranteed and Found.

[1] Distillers' dried grains from corn, rye, oats and barley.

[2] Distillers' dried grains (largely rye), from rye, oats and barley.

[3] Distillers' dried grains (largely corn), from corn, oats, barley and rye.

[4] Distillers' dried grains from corn, oats, rye and barley.

[5] Distillers' dried grains, residues from malted barley, malt sprouts.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	BREWERS' DRIED GRAINS (*concluded*):				
7186	Bartholomay Brewery Co.,		G*21.13	5.10	19.40
	Rochester, N. Y.	Hillsdale	F*22.9	7.2	16.6
	" Dried Brewers' Grains "				
6868	Farmers Feed Co.,		G 27.20	6.30	17.20
	Buffalo, N. Y.	Norwich	F 27.7	6.4	12.2
	" Bull Brand Dried Brewers Grains "				
6477	Farmers Feed Co.,		G 27.20	6.30	17.20
	Buffalo, N. Y.	Rensselaer	F 33.4	6.9	10.
	" Bull Brand Dried Brewers Grains "				
5698	Hottelet & Co.,		G 25.	5.	14.
	Milwaukee, Wis.	Liberty	F 26.5	7.25	12.
	" Holstein Dried Brewers Grains "				
7248	Milwaukee Grains & Feed Co.,		G 25.	5.	15.
	Milwaukee, Wis.	Monroe	F 29.5	6.5	11.9
	" Crown Brewers Dried Grains "				
6984	K. & E. Neumond,		G 24.	6.	13.
	St. Louis, Mo.	Binghamton	F 29.1	7.1	11.5
	" Goldnes Kalb Dried Brewers Grains "				
5294	M. G. Rankin & Co.,		G 26.	6.	16.
	Milwaukee, Wis.	Conklin	F 28.2	7.3	12.6
	" Durham Dried Brewers Grains "				
6989	Rosekrans-Snyder Co.,		G 25.	5.	18.
	Philadelphia, Pa.	Corbettsville	F 27.7	7.4	12.7
	" Pilsner Brewers Dried Grains "				
5566	Jos. Schlitz Brewing Co.,		G 24.	6.	16.
	Milwaukee, Wis.,	Walden	F 32.3	7.2	11.6
	" Schlitz Purity Dried Grains "				
	CORN GLUTEN FEED:				
6499	American Maize Products Co.,		G 23.	3.50	8.50
	New York, N. Y.	Schenectady	F 24.3	3.7	6.
	" Cream of Corn Gluten Feed "				
7067	Clinton Sugar Refining Co.,		G 23.	3.	8.
	Clinton, Ia.	East Meredith	F 26.6	3.7	6.3
	" Clinton Corn Gluten Feed "				
5689	Corn Products Refining Co.,		G 23.	1.	8.5
	New York, N. Y.	Walton	F 25.	4.5	6.6
	" Buffalo Corn Gluten Feed "				

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* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	CORN GLUTEN FEED (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
5283	Corn Products Refining Co.,		G* 23.	1.	8.5
	New York, N. Y.	New Berlin	F* 27.8	3.4	6.
	"Globe Corn Gluten Feed"				
6466	Corn Products Refining Co.,		G 23.	2.	8.5
	New York, N. Y.	Albany	F 24.4	3.7	4.5
	"Globe Gluten Feed"				
7423	Douglas Company,		G 20.	2.	8.
	Cedar Rapids, Ia.	Castile	F 20.7	4.3	5.7
	"Douglas Corn Gluten Feed"				
7194	J. C. Hubinger Bros. Co.,		G 23.50	2.40	7.50
	Keokuk, Ia.	Hudson	F 25.4	5.6	5.6
	"KKK Gluten Feed"				
7663	J. C. Hubinger Bros. Co.,		G 23.	2.40	7.50
	Keokuk, Ia.	St. Johnsville	F 27.6	3.1	5.7
	"KKK Gluten Feed"				
5693	Huron Milling Co.,		G 22.	3.	8.
	Harbor Beach, Mich.	Walton	F 24.	2.5	6.5
	"Jenks' Gluten Feed"				
7779	The Keever Starch Co.,		G 20.	3.	8.
	So. Columbus, O.	Barneveld	F 21.7	6.1	4.9
	"Keever Gluten Feed"				
7298	Piel Bros. Starch Co.,		G 23.	2.	8.
	Indianapolis, Ind.	Williamsville	F 28.8	2.4	5.7
	"P. Bro Corn Gluten Feed"[1]				
5856	A. E. Staley Mfg. Co.,		G 23.	2.50	12.
	Decatur, Ill.	Malone	F 25.2	3.7	5.6
	"Staley's Corn Gluten Feed"				
7159	Union Starch & Refining Co.,		G 23.	3.	8.
	Edinburg, Ind.	Stormville	F 25.7	3.4	5.9
	"Union Corn Gluten Feed"				
	CORN GLUTEN MEAL:				
6976	Corn Products Refining Co.,		G 40.	1.5	4.
	New York, N. Y.	Cincinnatus	F 43.	2.	1.8
	"Diamond Corn Gluten Meal"				
7470	Corn Products Refining Co.,		G 40.	1.50	4.
	New York.	Tuscarora	F 42.2	2.5	1.7
	"Diamond Corn Gluten Meal"				

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* These letters indicate, respectively, Guaranteed and Found.

[1] Artificially colored occasionally with Orange 122.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	HOMINY FEEDS:		*Per ct.*	*Per ct.*	*Per ct.*
5687	American Hominy Co.,		G* 9.50	7.	7.
	Indianapolis, Ind.	Walton	F* 10.8	7.5	4.1
	" Homco Feed "				
7269	Ames-Burns Co.,		G 9.	7.	5.
	Jamestown, N. Y.	Randolph	F 11.	7.1	4.6
	" A.-B.-C. Fine White Hominy "				
5678	M. F. Baringer,		G 9.	6.	10.
	Philadelphia, Pa.	Sidney	F 11.5	9.	2.3
	" Hominy Feed "				
7527	The Birkett Mills,		G ——	——	——
	Penn Yan, N. Y.	Penn Yan	F 9.4	4.6	4.7
	" Hominy "[1]				
6853	Buffalo Cereal Co.,		G 10.	6.	5.
	Buffalo, N. Y.	Norwich	F 11.	6.3	3.5
	" Bufceco Hominy Feed "				
6932	Chapin & Co.,		G 10.	7.	5.
	Hammond, Ind.	Poughkeepsie	F 10.6	7.4	4.3
	" Green Diamond Hominy Meal "				
7729	Deutsch & Sickert Co.,		G 9.	7.	4.
	Milwaukee, Wis.	Kingston	F 11.2	9.4	4.3
	" Success Hominy Feed "				
6968	East Waverly Milling Co.,		G 9.	6.	5.
	Waverly, N. Y.	Binghamton	F 10.1	7.5	3.1
	" Hominy Feed "				
7195	Elevator Milling Co.,		G 11.02	7.70	——
	Springfield, Ill.	Hudson Falls	F 9.4	4.9	3.7
	" Ideal Hominy Feed Kiln Dried "[2]				
7066	Empire Grain & Elevator Co.,		G 10.	7.	6.
	Binghamton, N. Y.	Grand Gorge	F 10.8	8.3	3.9
	" Pearl Hominy "				
6859	Evans Milling Co.,		G 10.	7.50	7.
	Indianapolis, Ind.	Norwich	F 11.5	8.6	4.4
	" Evans Hominy Feed "				
7165	U. S. Frumentum Co.,		G 9.50	7.30	7.
	Detroit, Mich.	Pawling	F 9.5	5.6	3.8
	" Frumentum Hominy Feed "[2]				

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* These letters indicate, respectively, Guaranteed and Found.

[1] Yellow hominy feed.

[2] Hominy feed containing small amounts of yellow corn and corn chaff.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	HOMINY FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*
7445	Chas. Herendeen Mfg. Co.,		G* 10.15	7.20	6.50
	Chicago, Ill.	Corfu	F* 10.7	8.	3.6
	" Herendeen's Hominy Feed "				
5271	Independent Hominy Co.,		G 10.85	8.23	7.20
	Portsmouth, O.	Afton	F 11.1	10.1	4.5
	" In. Ho. Co. Hominy Feed "				
6273	J. B. A. Kern & Sons,		G 9.5	6.5	4.
	Milwaukee, Wis.	Syracuse	F 11.4	9.8	4.
	" Pure Eagle Hominy Feed "				
7157	Chas. A. Krause Milling Co.,		G 10.	6.	5.
	Milwaukee, Wis.	Stormville	F 11.9	7.5	5.1
	" Badger Hominy Feed "				
7460	H. E. McEachron Co.,		G 11.25	8.50	4.
	Wausau, Wis.	Williamson	F 11.4	8.6	3.5
	" Hominy Feed "				
7680	H. E. McEachron Co.,		G 11.25	8.50	4.
	Wausau, Wis.	Syracuse	F 12.	10.	3.7
	" Hominy Feed "				
7239	Miner-Hillard Milling Co.,		G 10.	5.	5.
	Wilkes Barre, Pa.	Warwick	F 11.7	6.2	5.1
	" Choice Steam Cooked Hominy Feed "				
6978	Mystic Milling Co.,		G 11.	7.	4.
	Sioux City, Ia.	Blodgett Mills	F 11.	6.3	4.1
	" Hominy Feed "				
7664	A. Nowak & Son,		G 8.	6.	8.
	Buffalo, N. Y.	St. Johnsville	F 11.4	8.5	3.5
	" Justice Brand Hominy "				
6873	The Patent Cereals Co.,		G 10.	6.	5.
	Geneva, N. Y.	Hamilton	F 12.4	7.9	4.
	" Hominy Feed "				
6931	The Quaker Oats Co.,		G 9.	4.	4.
	Chicago, Ill.	Poughkeepsie	F 9.1	4.7	3.3
	" Yellow Hominy Feed "[1]				
7204	M. G. Rankin & Co.,		G 10.	6.	5.
	Milwaukee, Wis.	Schoharie	F 11.4	10.5	3.9
	" Jersey Hominy Feed "				

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* These letters indicate, respectively, Guaranteed and Found.

[1] Yellow hominy feed.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	HOMINY FEEDS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
6870	Suffern-Hunt Mills,		G* 9.30	7.10	10.
	Decatur, Ill.	Earlville	F* 11.	7.3	3.7
	" Acme Hominy Feed "				
7249	Thompson & Mould,		G 10.	7.	4.75
	Goshen, N. Y.	Monroe	F 12.1	9.1	2.4
	" Special Hominy Feed '				
6762	Thompson & Mould,		G 9.	5.50	7.
	Goshen, N.Y.	Penn Yan	F 10.	4.4	5.5
	" Hominy Meal "[1]				
7715	Not given		G ——	——	——
	" White Hominy Feed "	Washington-ville	F 11.8	7.8	3.5

* These letters indicate, respectively, Guaranteed and Found.

[1] Yellow hominy feed.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Cruds fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7763	J. J. Bartholomew & Son, Vernon, N. Y. "Vernon Dairy Feed"	Vernon	G* 24.	5.	10.	Distillers' dried grains, cottonseed meal, gluten feed, brewers' dried grains, corn meal, hominy, malt sprouts, wheat bran, linseed meal.
			F* 26.8	6.7	8.7	As certified.
7241	Belvidere Flouring Mill Co., Belvidere, N. J. "Mixed Feed"	Wisner	G 8.	2.40	20.	Corn cob feed, rye feed, oats.
			F 11.1	2.9	4.3	Rye bran, rye middlings, ground corn offal, small amounts of ground corn and oats.
6365	The J. W. Biles Co., Cincinnati, O. "Ubiko Horse and Stock Feed"	Macedon	G 16.	6.	9.	Wheat middlings, hominy meal, wheat bran, brewers' dried grains, old process linseed meal and nothing else.
			F 18.1	6.7	7.8	Wheat bran, wheat middlings, hominy feed, brewers' dried grains, linseed meal.
8017	The Blatchford Calf Meal Factory, Waukegan, Ill. "Blatchford's Pig Meal"	Troy	G 18.	5.	7.	Linseed oil meal, oat meal, wheat flour, barley meal, recleaned cottonseed meal, cocoa shell meal, bean meal, crushed flaxseed, fenugreek, salt, corn meal.
			F 19.6	5.3	7.3	As certified.
8002	S. W. Bowne Co., Brooklyn, N. Y. "Ground Feed"	Brooklyn	G 7.	3.	11.	Corn meal, hominy chops, oat hulls.
			F 9.7	4.1	4.1	Corn meal, hominy feed, oat hulls, small amounts of buckwheat and cob chaff.
5571	J. D. Braue, Inc., Jordan, N. Y. Braue's Mixed Feed"	New York City	G 12.	4.	12.	Crushed oats, crushed corn and alfalfa meal.
			F 13.4	3.2	13.8	As certified.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
5735	Buffalo Cereal Co., Buffalo, N. Y. " Bufceco Stock Feed "	Canajoharie	G* 8.	4.	9.	Ground corn and oats, wheat middlings, hominy feed, oat shorts, oat hulls, oat middlings.
			F* 9.2	6.	8.7	Ground corn and oats, wheat middlings, hominy feed, oat shorts, oat middlings, oat hulls, traces of buckwheat and kaffir corn.
6885	Buffalo Cereal Co., Buffalo, N. Y. " Iroquois Chop Feed "	Skaneateles	G 7.	3.	9.	Ground corn, hominy feed, oat bran, oat hulls.
			F 9.8	4.9	8.8	Ground corn, hominy feed, ground corn cob, oats, oat shorts, oat middlings, oat hulls.
6879	Chapin & Co., Hammond, Ind. " Unicorn Dairy Ration "	New Woodstock	G 26.	5.5	10.	Corn distillers' grains, cottonseed meal, linseed meal, hominy meal, gluten feed, corn starch by-product with corn bran, barley feed, malt sprouts, wheat bran, brewers' grains.
			F 28.5	6.5	10.2	Distillers' dried grains, cottonseed meal, linseed meal, corn gluten feed, feed barley, malt sprouts, wheat bran, brewers' dried grains, hominy meal.
7514	The Chesbro Milling Co., Salamanca, N. Y. " Chesbro's Stock Feed "	Weedsport	G 8.	3.25	9.	Made from corn, barley, cottonseed meal, red dog flour, oat shorts, oat midds, oat hulls, one-half of one per ct. salt.
			F 8.3	5.6	12.3	Oat hulls, oat shorts, oat middlings, hominy feed, ground barley, red dog flour, a trace of cottonseed meal, salt.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7448	Consolidated Milling Corp., Buffalo, N. Y. "Monarch Chop Feed"	Canandaigua	G* 7.	3.	9.	Corn feed meal, whole oats, wheat middlings, crushed oats, oat middlings, oat hulls, clipped oat by-products, salt, three-fourths of one per ct.
			F* 9.6	3.5	7.4	Corn feed meal, corn offal, whole and crushed oats, oat middlings, oat hulls, clipped oat by-product and screenings, a small amount of wheat middlings, salt.
7450	Consolidated Milling Corp., Buffalo, N. Y. "Monarch Chop Feed"	Canandaigua	G 7.	3.	12.	Ground oats, corn feed meal, hominy, oat hulls, clipped oat by-products, wheat middlings, salt three-fourths of one per ct.
			F 10.1	4.1	7.9	Crushed oats, corn feed meal, hominy feed, oat hulls, wheat middlings, traces of cottonseed meal, screenings and salt.
7709	W. H. Coonrod, Port Jervis, N. Y. "Horse Feed"	Port Jervis	G 8.	3.	14.	Ground corn, corn bran, ground oats, wheat and rye middlings, oat meal mill by-products (oat hulls and oat middlings) Star Feed (hominy feed and ground corn cob) wheat flour, and one-half of one per ct. salt.
			F 9.5	4.7	11.5	Ground corn, corn bran, wheat bran, wheat middlings, wheat flour, rye middlings, ground oats, oat shorts, oat middlings, oat hulls, hominy feed, ground corn cob, salt.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
5873	Dock & Coal Co., Plattsburg, N. Y. " Dandy Feed "	Plattsburg	G* 8.	5.	8.	Corn meal and oat middlings, oats and oat hulls.
			F* 9.3	4.0	5.1	As certified.
5277	R. D. Eaton Grain and Feed Co., Norwich, N. Y. " Eaton's Special Dairy Feed "	Norwich	G 12.	3.	12.	Alfalfa meal, oil meal, pea meal, brewers' grains, corn meal, cottonseed meal, oats and barley.
			F 12.9	4.1	8.9	Alfalfa meal, linseed meal, pea meal, brewers' dried grains, corn meal, cottonseed meal, kaffir corn meal, ground oats, barley and buckwheat.
7762	Elmore Milling Co., Oneonta, N. Y. " Council Rock Stock Feed "	Cooperstown	G 10.	5.	16.	Corn meal, hominy, dried brewers' grains, wheat bran, oat hulls, oat middlings, oat shorts, salt.
			F 10.	4.3	12.	As certified.
7737	Elmore Milling Co., Oneonta, N. Y. " Elmore's Milk Grains "	Stillwater	G 25.	6.	10.	Corn distillers' grains, old process oil meal, cottonseed meal, corn gluten feed, hominy feed, wheat bran, malt sprouts, dried brewers' grains, salt.
			F 25.2	6.1	8.9	As certified.
6610	Elmore Milling Co., Oneonta, N. Y. " Elmore's Stock Feed "	Hudson Falls	G 10.	5.	16.	Corn meal, hominy, dried brewers' grains, wheat bran, oat hulls, oat middlings, oat shorts, salt.
			F 10.	3.6	12.4	As certified.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7294	Faramel Mfg. Co., Buffalo, N. Y. "Faramel Dairy Feed"	Niagara Falls	G* 22.	3.	9.	Brewers' dried grains, corn gluten feed, linseed oil meal, wheat bran, molasses feed and one per ct. of salt.
			F* 21.9	5.9	8.5	Brewers' dried grains, corn gluten feed, linseed meal, wheat bran, a small amount of ground weed seeds, molasses, salt.
6270	General Flour and Feed Co., Buffalo, N. Y. "Big 4 Feed"	Syracuse	G 7.	3.	12.	Cracked corn, corn and cob meal, ground oat hulls, oat middlings, corn bran.
			F 7.2	3.4	13.6	As certified.
6951	General Flour & Feed Co., Buffalo, N. Y. "Honest Cow Feed"	Tully	G 24.	6.	9.	Distillers' dried grains, gluten, brewers' dried grains, wheat middlings, corn meal, wheat bran, one per ct. salt, corn bran, cottonseed meal, linseed meal.
			F 27.	7.8	7.7	Distillers' dried grains, corn gluten feed, brewers' dried grains, wheat bran, wheat middlings, corn meal, corn bran, cottonseed meal.
6271	General Flour and Feed Co., Buffalo, N. Y. "Standard M. & S.	Syracuse	G 10.	3.	10.	Wheat bran, Buffalo meal which is composed of corn and cob meal, the amount of cob used being the same as though ear corn was ground cob and all.
			F 12.2	5.	6.	Wheat bran, containing ground screenings, corn and cob meal.

7756	Gilbert & Nichols Co., Fulton, N. Y. "Fulton Dairy Feed"	Fulton	G	25.	5.	9.	Distillers' grains, malt sprouts, brewers' grains, cottonseed meal, old process oil meal, corn gluten feed, wheat bran, corn meal, ground oats and buckwheat middlings nearly free from shucks mixed with a very small quantity of salt.
			F	26.9	6.1	7.8	Distillers' dried grains, brewers' dried grains, malt sprouts, cottonseed meal, corn gluten feed, wheat bran, corn meal, ground oats, buckwheat middlings, buckwheat hulls, salt, linseed meal.
5728	Globe Elevator Co., Buffalo, N. Y. "Buffalo Dairy Mixed Feed"	Mohawk	G	12.	5.	9.	Wheat bran with ground screenings, corn bran, wheat flour, wheat middlings, salt three-fourths of one per ct.
			F	13.5	6.65	5.9	Corn bran, wheat middlings, low grade wheat flour, ground screenings, small amount of wheat bran, salt.
6814	Globe Elevator Co., Buffalo, N. Y "No. 1 Chop Feed"	Sterlingville	G	7.	3.	9.	Ground corn and oats and oat hulls, flour middlings, salt one-half of one per ct.
			F	8.8	3.3	10.2	Ground corn and oats, oat hulls, flour middlings, salt.
5730	Globe Elevator Co., Buffalo, N. Y. "Buffalo Stock Feed"	Frankfort	G	9.	4.	9.	Corn, barley, oats, red dog flour, oat hulls, oat middlings, hominy feed, cottonseed meal, salt three-fourths of one per ct.
			F	12.1	3.7	7.2	Ground barley, and oats, oat middlings, oat hulls, yellow hominy feed, red dog flour, cottonseed meal, salt.
7542	Gorham Mill Co., Gorham, N. Y. "Hominy and Bran Feed"	Gorham	G	——	——	——	Two parts hominy, 1 part bran.
			F	11.7	6.1	5.1	Hominy feed, wheat bran.

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* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7287	J. Gorham, Buffalo, N. Y. " Boat Sweepings "	Buffalo	G* 5.	2.	14.	This commodity is composed of sweepings from boats loaded with flour and feed, and consists of several materials having feeding stuffs value; but it is impossible to name each ingredient contained therein.
			F* 16.4	3.5	5.1	Boat sweepings consisting largely of wheat bran, wheat middlings, wheat flour, corn gluten meal, small amounts of corn, oats, barley, peas, and alfalfa.
7414	D. H. Grandin Milling Co., Jamestown, N. Y. " Grandin's Stock Food "	Warsaw	G 8.50	3.50	10.	Pure oats, corn, barley, barley screenings, hominy feed, oat hulls and salt.
			F 9.9	5.9	8.4	Ground corn, oats, barley, barley screenings, containing barley hulls, hominy feed, oat hulls, salt.
5669	W. H. Haskell & Co., Toledo, O. " Haskell's Stock Feed "	East Branch	G 8.	4.	8.	Ground corn, ground oats, hominy feed, oat hulls, oat shorts and salt.
			F 9.4	6.8	6.8	As certified.
7700	The Hecker Cereal Co., New York, N. Y. " Heckers' Stock Feed "	Oswego	G 10.	4.	9.	Ground corn, ground barley, red dog, oat middlings, oat shorts, oat hulls, hominy feed, cottonseed meal, salt one-half of one per ct.
			F 10.	4.7	9.3	Ground corn, ground barley, red dog flour, oat middlings, oat shorts, oat hulls, hominy feed, cottonseed meal, salt.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7475	Indiana Milling Co., Terre Haute, Ind. " Sterling Feed "	Strykersville	G* 10.	3.	16.	Wheat bran with ground screenings not exceeding mill run, ground corn, cob meal.
			F* 10.7	3.5	14.5	Wheat bran containing ground screenings, corn and cob meal.
7805	Indiana Milling Co., Terre Haute, Ind. " Sterling Feed "	Oxford	G 10.	3.	16.	Wheat bran with ground screenings not exceeding mill run, ground corn, cob meal.
			F 10.1	3.4	15.7	Wheat bran containing ground screenings, ground corn, cob meal.
6278	Jamestown Electric Mills, Jamestown, N. Y. " Jem Stock Feed "	McGraw	G 9.	3.	10.	Yellow or white corn meal, oats, oat middlings, ground oat hulls, one-half pound of fine salt per one hundred pounds.
			F 9.6	5.3	9.2	White corn meal, ground oats, oat middlings, oat shorts, oat hulls, salt.
7272	Jamestown Electric Mills, Jamestown, N. Y. " Purity Milk Maker "	Sinclairville	G 22.	7.	11.	Composed of distillers' dried grains, wheat bran, wheat middlings, corn gluten feed, cottonseed meal, linseed oil meal, corn meal, malt sprouts, and a small percentage of fine salt, nothing more.
			F 25.1	6.6	8.5	As certified.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6621	Lapham & Parks, Glens Falls, N. Y. "Corn, Oat & Rye Feed"	Glens Falls	G* ——	——	——	
			F* 11.7	3.9	5.7	Ground corn, oats and rye, ground corn cob.
6923	The Larrowe Milling Co., Detroit, Mich. "Larro-Feed"	Poughkeepsie	G 19.	3.	14.	Cottonseed meal, gluten feed (corn starch by-product with corn bran), dried distillers' grains, dried beet pulp, wheat bran, wheat middlings and three-fourths of one per ct. salt.
			F 21.5	4.1	10.4	Cottonseed meal, corn gluten feed, distillers' dried grains, dried beet pulp, wheat bran, wheat middlings, salt.
6882	Law & Wilber, Collins, N. Y. "Square Deal Dairy Ration"	New Woodstock	G 25.	7.	11.	Corn distillers' grains, hominy and corn meal, owl 41 per ct. cottonseed meal, fancy winter wheat bran, old process oil meal, fancy malt sprouts, gluten feed made from corn.
			F 22.7	6.1	7.3	Distillers' dried grains, hominy feed, corn meal, cottonseed meal, linseed meal, corn gluten feed, wheat bran, malt sprouts.
7726	Matthews and Harrison, Kingston, N. Y. "Arcade Stock Feed"	Kingston	G 6.50	2.50	15.	Hominy feed, ground corn, wheat middlings, corn bran, oat feed, ground oat screenings and salt.
			F 11.1	4.1	5.7	Ground corn, hominy feed, corn bran, wheat middlings, oats, ground oat screenings, containing light oats and oat hulls, salt.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7415	A. Nowak & Son, Buffalo, N. Y. "Buffalo Horse Feed"	Warsaw	G* 7.	3.	12.	Ground oats, corn feed meal, hominy feed, oat hulls, clipped oat by-products, wheat middlings and three-fourths of one per ct. salt.
			F* 10.	3.5	7.6	Ground oats, corn feed meal, oat hulls, hominy feed, a small amount of wheat middlings, screenings and salt.
7357	Odgensburg Roller Mills, Ogdensburg, N. Y. "Oswegatchie Feed"	Ogdensburg	G 7.04	3.03	11.11	Corn meal, crushed oats, oat hulls, and corn cob meal.
			F 7.6	2.5	8.9	Corn meal, oats, oat hulls, ground corn cob, and a small amount of whole weed seeds.
7711	Wm. Orr & Sons, Orr's Mills, N. Y. "Orr's Mixed Feed"	Orr's Mills	G 7.	2.	15.	Whole corn, corn feed meal, corn bran, whole oats, rye middlings, wheat middlings, salt, clipped oat by-product.
			F 9.6	3.9	2.9	Ground corn, corn feed meal, corn bran, crushed oats, rye middlings, wheat middlings, small amounts of buckwheat and weed seeds, salt.
7482	Phelps & Sibley Co., Cuba, N. Y. "Yellow P. & S. Feed"	Rathbone	G 7.	3.	9.	Western corn and oat hulls.
			F 7.9	3.2	7.	Ground corn, oat hulls.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*)

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6691	The Quaker Oats Company, Chicago, Ill. "Sterling Feed"	Newport	G* 10.	3.25	10.	Ground corn, hominy feed, ground barley, wheat flour, wheat middlings with ground screenings not exceeding mill run, cottonseed meal, ground puffed wheat, ground puffed rice, oat meal mill by-products, oat middlings, oat hulls, oat shorts, one-half of one per ct. salt.
			F* 10.7	3.9	9.9	As certified.
6468	Quaker Oats Company, Chicago, Ill. "Sterling Stock Feed"	Albany	G 10.	3.25	10.	Made from ground corn, ground barley, wheat flour, ground puffed rice, ground puffed wheat, wheat middlings, hominy feed, cottonseed meal, oat meal mill by-product (oat middlings, oat hulls, oat shorts) and one-half of one per ct. salt.
			F 11.	4.1	9.3	As certified.
7178	The Quaker Oats Company, Chicago, Ill. "Victor Feed"	Amenia	G 8.	3.	12.	Ground corn, hominy feed, oat meal mill by-products (oat middlings, oat hulls, oat shorts) and one-half of one per ct. salt.
			F 9.3	4.2	10.8	Ground corn, hominy feed, oat middlings, oat shorts, oat hulls, salt.
6683	The Quaker Oats Company, Chicago, Ill. "White Diamond Feed"	Barneveld	G 8.	3.25	9.	Ground corn, hominy feed, oat meal mill by-product, oat middlings, oat hulls, oat shorts, one-half of one per ct. salt.
			F 8.4	3.8	7.8	As certified.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
6995	Syracuse Milling Co., Syracuse, N. Y. "Syragold Stock Feed"	Wampsville	G* 7.50	3.	12.	Ground corn and cob, oats, oat hulls, oat feed, dried brewers' grains, three-fourths of one per ct. salt.
			F* 8.9	3.2	10.1	Corn and cob meal, oats, oat shorts, oat middlings, oat hulls, brewers' dried grains, salt.
6819	Syracuse Milling Co., Syracuse, N. Y. "Syragold Stock Feed"	Lafargeville	G 7.50	3.	12.	Ground corn and cob, oats, oat hulls, oat midds, dried brewers' grains, three-fourths of one per ct. salt.
			F 9.1	5.3	10.1	Ground corn and cob, brewers' dried grains, oats, oat shorts, oat middlings, oat hulls, salt.
6494	Tioga Mill & Elevator Co., Waverly, N. Y. "Derby Stock Feed"	Watervliet	G 10.50	4.90	9.	Corn offal, hominy, gluten, oat middlings, oat hulls.
			F 11.8	5.7	10.5	Hominy feed, corn gluten feed, oat middlings, oat hulls, corn offal.
6488	Tioga Mill & Elevator Co., Waverly, N. Y. "Economy Feed"	Schenectady	G 10.	5.	17.25	Hominy, brewers' grains, corn offal, cob meal, oat hulls, and oat middlings.
			F 10.6	4.3	15.3	Hominy feed, brewers' dried grains, wheat bran, ground corn cob, corn offal, oat middlings, oat hulls.
7177	Toledo Elevator Branch, American Hominy Co., Indianapolis, Ind. "Star Feed"	Amenia	G 7.	5.50	12.50	Composed of hominy feed and ground corn cob containing one-half of one per ct. salt.
			F 8.8	6.3	11.	Hominy feed, ground corn cob, a trace of salt.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES:		*Per ct.*	*Per ct.*	*Per ct.*	
7243	American Milling Co., Peoria, Ill. "Mixing Feed"	Bullville	G* 12.	2.50	12.	Compounded with ground and bolted grain screenings, molasses, clipped oat by-product, cottonseed meal and salt.
			F* 14.5	5.8	12.	Cottonseed meal, clipped oat by-product, ground grain screenings, molasses, salt.
6854	American Milling Co., Peoria, Ill. "Sucrene Dairy Feed"	Norwich	G 16.50	3.50	12.	Molasses, cottonseed meal, corn gluten feed, ground and bolted grain screenings, clipped oat by-product, linseed meal and salt.
			F 19.4	6.4	11.7	Cottonseed meal, corn gluten feed, linseed meal, clipped oat by-product and ground grain screenings, molasses, salt.
7810	American Milling Co., Peoria, Ill. "Sucrene Horse and Mule Feed with Alfalfa"	Owego	G 10.	2.50	12.	Molasses, alfalfa, oats, corn, barley and salt.
			F 11.	2.5	10.4	Cracked corn, whole oats and barley, alfalfa meal, molasses, salt.
7409	Attica Mills, Chesbro Bros., Attica, N. Y. "Molasses Screening Feed"	Attica	G 10.	2.	10.	Grain screenings and molasses.
			F 13.8	4.7	9.9	Ground grain screenings, molasses.
7004	J. D. Braue, Inc., Jordan, N. Y. "Braue's Mixed Feed with Molasses"	Jordan	G 10.	2.	12.	A mixture of crushed oats, crushed corn and alfalfa meal.
			F 8.4	1.7	8.2	Crushed oats, crushed corn, alfalfa meal, molasses

7532	Geo. E. Brisbin & Co., Clyde, N. Y. "Blue Bell Dairy Feed'	Auburn	G 16.	3.	15.	Cottonseed meal, malt sprouts, clipped oat by-products, ground and bolted grain screenings, molasses and one-half of one per ct. salt.
			F 17.1	7.	8.8	Cottonseed meal, malt sprouts, clipped oat by-product, ground grain screenings containing a rather large amount of weed seeds, molasses, salt.
5599	Brooklyn Elevator and Milling Co., Brooklyn, N. Y. "Bemco Feed"	Brooklyn	G 9.	2.	15.	Corn, oats, alfalfa, molasses.
			F 9.9	2.	10.6	Cracked corn, crushed oats, alfalfa meal, molasses.
6354	Chesbro Milling Co., Inc., Salamanca, N. Y. "Creamal Dairy Feed"	Livonia	G 16.	4.	11.	Cottonseed meal, distillers' grains, malt sprouts, ground wheat screenings and molasses.
			F 14.6	4.5	8.3	Cottonseed meal, distillers' dried grains, malt sprouts, ground grain screenings, molasses.
5670	Clover Leaf Milling Co., Buffalo, N. Y. "Clover Leaf Dairy Feed."	Stamford	G 16.50	3.50	12.	Cottonseed meal, corn gluten feed, mixed broken grains consisting of wheat, corn, barley, flax, spelts, ground grain screenings, clipped oat by-product, molasses and a small percentage of salt.
			F 18.6	4.7	12.6	Cottonseed meal, clipped oat by-product, ground grain screenings, small amount of corn gluten feed, molasses, salt.
5872	Clover Leaf Milling Co., Buffalo, N. Y. "Clover Leaf Horse Feed"	Champlain	G 10.	2.	15.	Cracked corn, crushed oats, alfalfa meal, molasses and a small percentage of salt.
			F 11.3	2.9	12.5	As certified.

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* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
6695	Clover Leaf Milling Co., Buffalo N. Y. " Peerless Dairy Ration "	Little Falls	G*21.	4.	10.	Cottonseed meal, wheat bran with screenings not exceeding mill run, distillers' grains, corn gluten feed, clipped oat by-product, molasses and a small percentage of salt.
			F* 21.5	5.8	11.2	Cottonseed meal, wheat bran, distillers' dried grains, corn gluten feed, clipped oat by-product, ground grain screenings, molasses, salt.
7260	Consolidated Milling Corp., Buffalo, N. Y.		G 8.	2.	9.	Crushed oats, cracked corn, corn feed meal, wheat bran and molasses.
	"Husted O-Molene Horse Scientific Feed"	Akron	F 10.	4.6	5.1	As certified.
6352	Consolidated Milling Corporation, Buffalo, N. Y.	Oakfield	G 8.	2.	9.	Crushed oats, cracked corn, corn feed meal, wheat bran, molasses.
	"Vim-O-Lene Horse Feed"		F 9.3	3.6	4.5	As certified.
5580	The Corno Mills Co., St. Louis, Mo. "Corno Sweet Feed"	New York City	G 10.	2.5	12.	Mixture of whole oats, cracked corn, ground alfalfa, cane molasses, cotton seed meal, oat middlings, oat shorts and oat hulls.
			F 11.6	2.6	14.4	Whole oats, cracked corn, alfalfa meal, cottonseed meal, oat middlings, oat shorts, oat hulls, ground grain screenings consisting largely of weed seeds, molasses.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7801	Empire Grain & Elevator Co., Binghamton, N. Y. " Egee Dairy Feed "	Itaska	G* 16.	2.	15.	Cottonseed meal, malt sprouts, brewers' dried grains, alfalfa meal, ground and bolted screenings from wheat and flax, one-fourth of one per ct. salt and molasses.
			F* 16.4	5.	11.	Cottonseed meal, malt sprouts, brewers' dried grains, alfalfa meal, ground grain screenings, flax screenings, molasses, salt.
6296	Faramel Mfg. Co., Buffalo, N. Y. " Boggs Ceramel Horse Feed "	Syracuse	G 8.	2.	8.	Oats, corn, barley, wheat bran and molasses.
			F 10.7	3.1	5.5	Cracked corn, crushed oats, and barley, wheat bran, molasses.
7441	Faramel Mfg. Co., Buffalo, N. Y. " Faramel Horse Feed "	Le Roy	G 9.	4.	6.	Oats, corn, wheat bran and molasses.
			F 8.6	3.7	3.4	As certified.
7188	Globe Elevator Co., Buffalo, N. Y. " Anchor Dairy Feed "	Philmont	G 18.	4.	12.	Cottonseed meal, corn gluten feed, linseed oil meal, malt sprouts, rye and corn distillers' dried grains, corn meal, corn bran, ground grain screenings, clipped oat by-products, wheat middlings, molasses, salt three-fourths of one per ct.
			F 20.1	8.7	8.1	Cottonseed meal, corn gluten feed, linseed meal, malt sprouts, distillers' dried grains, corn meal, corn bran, wheat middlings, clipped oat by-product, grain screenings containing weed seeds partly ground, molasses, salt.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7498	The H-O Mills, Buffalo, N. Y. "The H-O Co's New England Stock Feed"	Castile	G* 9.	4.	10.	Wheat middlings, ground corn, hominy feed, oat hulls, oat shorts, ground oats, ground grain screenings, molasses, salt one-half of one per ct.
			F* 11.	6.3	9.6	As certified.
7724	International Sugar Feed Co., Minneapolis, Minn. "Dan Patch Horse Feed"	Kingston	G 12.50	3.50	12.	Oats, barley, corn, alfalfa, linseed oil meal, molasses, salt.
			F 13.1	3.8	7.6	As certified.
7216	International Sugar Feed Co., Minneapolis, Minn. "International Climax Feed"	Cambridge	G 12.50	4.	12.	Composed of cottonseed meal, molasses, ground clipped oat by-product, salt, ground cleaned grain screenings.
			F 12.8	4.3	11.3	Cottonseed meal, clipped oat by-product, ground grain screenings, molasses, salt.
7176	International Sugar Feed Co., Minneapolis, Minn. "International Dairy Feed"	Amenia	G 18.	4.50	12.	Cottonseed meal, molasses, ground cleaned grain screenings, ground clipped oat by-product, salt.
			F 17.9	6.7	11.5	Cottonseed meal, clipped oat by-product, grain screenings containing weed seeds partly ground, molasses, salt.
7215	International Sugar Feed Co., Minneapolis, Minn. "International Dan Patch Special Horse Feed"	Cambridge	G 9.	3.	15.	Composed of oats, barley, cracked corn, ground alfalfa, cane molasses, salt.
			F 9.3	3.	10.5	Cracked corn, oats, barley, alfalfa meal, molasses, salt.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7309	Kornfalfa Feed Milling Co., Kansas City, Mo. " Kornfalfa Kandy Feed "	Buffalo	G* 9.	2.50	12.	Alfalfa, corn, oats, molasses.
			F* 8.8	2.4	10.9	Alfalfa meal, cracked corn, crushed oats, molasses.
7185	Chas. A. Krause Milling Co., Milwaukee, Wis. " Badger Dairy Feed "	Millerton	G 16.	2.	15.	Cottonseed meal, corn oil meal, malt sprouts, dried brewers' grains, alfalfa meal, molasses, one-fourth of one per ct. salt, ground and bolted screenings from wheat and flax.
			F 16.4	4.3	11.2	Cottonseed meal, malt sprouts, brewers' dried grains, corn germ meal, alfalfa meal, ground grain screenings containing weed seeds partly ground, molasses, salt.
7707	Chas. A. Krause Milling Co., Milwaukee, Wis. " Badger Horse Feed "	Chester	G 10.	2.	12.	Made from corn, oats, alfalfa meal, salt and molasses.
			F 11.	2.1	8.5	Cracked corn, crushed oats, alfalfa meal, molasses, salt.
5576	Chas. A. Krause Milling Co., Milwaukee, Wis. " Derby Horse Feed "	New York City	G 10.	1.	16.	Corn, oats, alfalfa meal, molasses and salt.
			F 10.8	1.7	11.8	Cracked corn, crushed oats, alfalfa meal, molasses, salt.
5726	Molassine Co., Boston, Mass. " Molassine Sphagnum Feed "	Edmeston	G 7.	.50	7.	Molasses and cooked sphagnum moss.
			F 8.9	.5	4.6	As certified.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
6934	G. E. Patterson & Co., Memphis, Tenn. "Crown Horse Feed"	Beacon	G* 9.	2.	12.	Made from corn, oats, alfalfa, molasses.
			F* 9.2	1.3	2.9	Cracked corn, alfalfa meal, molasses and a small amount of oats.
6935	G. E. Patterson & Co., Memphis, Tenn. "Katl-Eat Dairy Feed"	Beacon	G 15.	3.	12.	Made from corn, molasses, alfalfa, rice straw and cotton seed meal.
			F 16.	3.1	7.8	Cracked corn, alfalfa meal, rice straw, rice hulls, cottonseed meal, molasses.
6483	M. C. Peters Mill Co., Omaha, Neb. "Peters Arab Horse Feed"	Albany	G 9.	2.	15.	A balanced ration of corn, oats, alfalfa and molasses.
			F 10.2	2.1	6.9	Cracked corn, oats, alfalfa meal, molasses.
6949	M. C. Peters Mill Co., Omaha, Neb. "Peters' King Corn, Oats, Alfalfa and Molasses Feed"	Beacon	G 9.	1.50	18.	Corn, oats, alfalfa, molasses.
			F 11.	1.8	8.6	Cracked corn, oats, alfalfa, molasses.
7181	M. C. Peters Mill Co., Omaha, Neb. "June Pasture"	Amenia	G 10.	.50	26.	Pure alfalfa meal, light with molasses.
			F 12.1	.9	14.8	Alfalfa meal, molasses.
7306	M. C. Peters Mill Co., Omaha, Neb. "Peters' Re-Peter Horse Feed"	Buffalo	G 9.	1.50	18.	Corn, oats, alfalfa and molasses.
			F 9.2	2.	15.5	Cracked corn, whole oats, alfalfa meal, molasses.
6668	The Quaker Oats Company, Chicago, Ill. "Blue Ribbon Dairy Feed"	Boonville	G 25.	4.	8.	Wheat bran, cottonseed meal, malt sprouts, molasses, hominy feed and oat clippings.
			F 25.2	4.7	11.4	Wheat bran, cottonseed meal, linseed meal, malt sprouts, hominy feed, oat hulls, molasses.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
6933	Quaker Oats Company, Chicago, Ill. " Quaker Molasses Dairy Feed "	Poughkeepsie	G* 16.	3.50	14.	Cottonseed meal, malt sprouts, molasses, grain screenings meal, flax by-products, oat meal by-products, oat middlings, oat hulls, oat shorts.
			F* 15.3	4.3	17.8	Cottonseed meal, malt sprouts, ground grain screenings, flax plant by-product, oat hulls, oat shorts, oat middlings, a small amount of molasses.
6364	Ralston Purina Co., St. Louis, Mo. " Good Luck Feed with Molasses "	Rochester	G 9.	1.5	12.	Cracked corn, whole oats, ground alfalfa, molasses and one per ct. salt.
			F 9.6	2.2	9.2	As certified.
7292	Ralston Purina Co., St. Louis, Mo. " Protena Dairy Feed "	Niagara Falls	G 16.5	3.5	12.	Cottonseed meal, brewers' dried grains, clipped oat by-product, ground wheat screenings, molasses and one per ct. salt.
			F 19.4	5.	10.8	Cottonseed meal, brewers' dried grains, clipped oat by-product, ground grain screenings, light oats, molasses, salt.
5562	Ralston Purina Company, St. Louis, Mo. " Purina Cow Chow Feed "	Kingston	G 24.	5.	12.	Made from cottonseed meal, hominy feed, brewers' dried grains, molasses, ground alfalfa and one per ct. salt.
			F 25.3	5.6	13.4	Cottonseed meal, hominy feed, brewers' dried grains, alfalfa meal, molasses, salt.
5563	Ralston Purina Co., St. Louis, Mo. " Purina Dairy Feed "	Kingston	G 20.	3.8	15.	Made from cottonseed meal, brewers' dried grains, corn feed meal, ground alfalfa, molasses and one per ct. salt.
			F 19.0	4.	14.5	As certified.

6360	Ralston Purina Co., St. Louis, Mo., " Purina Feed with Molasses "	Rochester	G	9.3	1.7	11.7	Cracked corn, whole oats, ground alfalfa, molasses and one per ct. salt.
			F	10.	2.7	9.	As certified.
6998	Republic Milling Co., East St. Louis, Mo. " Republic Horse and Mule Feed "	Kirkville	G	12.	3.5	12.	Cracked corn, oats, alfalfa meal and molasses.
			F	9.3	2.8	10.6	As certified.
6997	Republic Milling Co., East St. Louis, Mo. " Republic Sugar Feed "	Kirkville	G	16.5	3.	12.	Cottonseed meal, malt sprouts, oat clips, ground barley and flax screenings, salt and molasses.
			F	15.6	4.3	12.8	Cottonseed meal, oat clippings and ground grain screenings containing weed seeds partly ground, flax screenings, small amount of molasses, salt, malt sprouts.
5584	Somers & Co., San Francisco, Cal. " Economy Horse Feed "	New York City	G	9.5	2.1	9.1	
			F	8.7	1.7	9.1	Rolled barley, alfalfa meal, molassec.
5297	The Sugarine Company, Peoria, Ill. " Mixing Feed "	Whitney Point	G	12.	2.50	12.	Ground and bolted grain screenings, molasses, clipped oat by-product cottonseed meal and salt.
			F	13.2	5.7	12.5	Clipped oat by-product, ground grain screenings, cottonseed meal, molasses, salt.
7226	The Sugarine Company, Peoria, Ill. " Sugarine Dairy Feed "	Petersburg	G	16.50	3.50	12.	Molasses, cottonseed meal, gluten feed, ground and bolted grain screenings, clipped oat by-product, linseed meal and salt.
			F	18.3	6.2	11.3	Molasses, cottonseed meal, small amount of corn gluten feed, ground grain screenings, clipped oat by-product, linseed meal, salt.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
6473	United States Sugar Feed Co., Milwaukee, Wis. "U. S. Sugar Feed"	Albany	G* 13.	3.	12.	Cottonseed meal, molasses, oat clippings, flax plant by-product, ground and bolted grain screenings and a small percentage of salt.
			F* 15.5	5.5	11.2	As certified.
7054	U. S. Sugar Feed Co., Milwaukee, Wis. "U. S. Sugared Feed"	Delhi	G 15.	3.	12.	Cottonseed meal, mixed broken grains taken from screenings, containing corn, oats, barley, wheat, oat clippings, molasses, salt.
			F 17.9	6.3	12.2	Cottonseed meal, oat clippings, ground grain screenings, molasses, salt.
8011	Warner & Stellwagen, Brooklyn, N. Y. "Sterling Horse Feed"	Brooklyn	G 10.	4.	6.	Crushed oats, cracked corn, rice bran, molasses.
			F 9.5	5.5	6.1	As certified.
7716	The Wash-Co. Alfalfa M. F. & Mill'g Co., Ft. Calhoun, Neb. "Butlers Special Alfalfa Horse Feed"	Middletown	G 10.	2.	15.	Corn, oats and alfalfa, flavored with syrup.
			F 10.6	2.4	8.9	Cracked corn, whole oats, alfalfa meal, molasses.
7229	The Western Grain Products Co., Hammond, Ind. "Chicago Horse and Mule Feed"	New Hampton	G 10.	3.	15.	Corn, oats, alfalfa, linseed meal, molasses and three-tenths of one per ct. salt
			F 11.7	2.	11.6	Cracked corn, oats, alfalfa meal, linseed meal, molasses, salt.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7279	American Milling Co., Peoria, Ill. " Sucrene Chick Feed with 5% Grit "	Olean	G* 10.	2.50	5.	Corn, kaffir corn, wheat, millet, pigeon grass and marble grit.
			F* 10.1	2.9	2.4	Cracked corn, kaffir corn, wheat, millet, weed seeds, marble grit.
6692	American Milling Co., Peoria, Ill. " Sucrene Scratch Feed "	Newport	G 10.	2.50	5.	Corn, wheat, kaffir corn, linseed oil cake, sunflower seed, buckwheat and barley.
			F 12.2	2.5	2.5	Cracked corn, wheat, kaffir corn, linseed oil cake, sunflower seed, buckwheat, barley.
7301	W. J. Beier, Jr., Buffalo, N. Y. " Frontier Poultry Mash "	Buffalo	G 15.	4.	6.	Rolled oats, wheat bran, hominy feed, wheat middlings, corn gluten feed, ground corn, oat middlings.
			F 15.7	5.8	4.3	Wheat bran, wheat middlings, ground corn, hominy feed, corn gluten feed, rolled oats, oat middlings.
6763	The Birkett Mills, Penn Yan, N. Y. " Victrix Egg Mash "	Penn Yan	G 19.	4.	4.	Ground beans, wheat bran, linseed meal, wheat middlings, corn meal and cottonseed meal.
			F 20.6	4.3	5.1	As certified.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
8004	S. W. Bowne & Co., Brooklyn, N. Y. "Bowne's Dry Mash for Poultry"	Brooklyn	G* 19.	4.	7.	Wheat midds, bran, corn meal, linseed oil meal, meat scrap, alfalfa meal.
			F* 21.1	5.9	5.4	Wheat bran, wheat middlings, corn meal, linseed meal, meat scraps, alfalfa meal.
5597	Brooklyn Elevator & Milling Co., Brooklyn, N. Y. "Bemco Poultry Mash"	Brooklyn	G 12.	3.	5.	Corn meal, corn gluten feed, wheat bran, old process oil meal, wheat middlings, heneta grits.
			F 14.5	3.4	3.4	Corn meal, corn gluten feed, wheat bran, wheat middlings, linseed meal, heneta grit.
7687	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Poultry Mash"	Schenevus	G 15.	4.	6.	Ground corn, wheat bran and middlings, hominy feed, corn gluten feed, oat middlings and rolled oats.
			F 15.7	5.9	4.9	As certified.
7297	Buffalo Cereal Co., Buffalo, N. Y. "Iroquois Poultry Mash"	Buffalo	G 14.	4.	12.	Ground corn, wheat bran and middlings, corn gluten feed, alfalfa meal.
			F 16.2	5.5	10.8	As certified.
6300	The G. F. Conkey Co., Cleveland, O. "Conkey's Starting Food for Chicks"	Syracuse	G 12.	4.	4.	Corn, wheat, wheat middlings, hulled oats, meat, bone, salt, sulphur, iron sulphate, gentian root, bone ash and mustard seed.
			F 16.5	4.0	2.7	Corn meal, ground wheat, wheat middlings, oat groats, meat and bone meal, salt, sulphur, iron sulphate, calcium phosphate, gentian, mustard

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7211	Daniel Eddy & Sons, Saratoga Springs, N. Y. "Eddyson Dry Mash"	Saratoga Springs	G* 12.	3.	4.	Corn meal, gluten, wheat middlings, wheat bran, pea meal, oil meal, heneta, composed of phosphorus, silica, lime and soda.
			F* 15.1	3.2	3.9	Corn meal, corn gluten meal, wheat bran, wheat middlings, linseed meal, heneta grit.
6611	Elmore Milling Co., Oneonta, N. Y. "Chick Feed"		G ——	——	——	
		Hudson Falls	F 11.6	3.6	2.7	Cracked corn, cracked kaffir corn, cracked wheat, oat groats, millet seed, flax seed, wild buckwheat, foxtail, pigweed.
7205	Elmore Milling Co., Oneonta, N. Y. "Elmore Dry Mash Feed"	Schoharie	G 15.	4.	7.	Contains wheat bran, white wheat middlings, corn meal, hominy feed, old process oil meal, alfalfa meal, barley meal, salt, corn gluten feed.
			F 16.	3.3	7.5	Wheat bran, wheat middlings, alfalfa meal, corn meal, linseed meal, corn gluten feed, hominy feed, kaffir corn, wheat, oats, barley, millet.
8010	William Germuth, Richmond Hill, N. Y. "Dunton Poultry Mash"	Richmond Hill	G 17.38	4.64	7.30	Alfalfa meal, wheat middlings, wheat bran, rolled oats, corn meal, linseed meal, meat scraps.
			F 17.3	4.3	8.8	Alfalfa meal, wheat bran, wheat middlings, corn meal, meat scraps.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7549	The Hen-ty Mfg. Co., Auburn, N. Y. " The Hen-ty Laying Mash "	Auburn	G* 16.	5.	6.	Linseed meal, cottonseed meal, corn gluten feed, corn meal, wheat bran, wheat middlings, ground oats, hominy feed, fish scraps, beef scraps, bone meal, meat meal, oyster shell meal, alfalfa meal, charcoal.
			F* 16.1	6.2	5.7	As certified.
6804	A. H. Herrick & Son, Watertown, N. Y. " Herricks Quality Soft Feed for Poultry "	Watertown	G 22.31	6.69	6.77	Oil meal, corn meal, wheat bran, wheat middlings, alfalfa meal and beef scraps.
			F 21.9	5.7	7.4	Linseed meal, corn meal, wheat bran, wheat middlings, alfalfa meal, pea meal, meat scrap.
6824	A. H. Herrick & Son, Watertown, N. Y. " Herricks Quality Soft Feed "	Watertown	G 22.31	6.69	6.77	Oil meal, corn meal, wheat bran, wheat middlings, alfalfa meal, beef scraps.
			F 20.7	6.7	5.2	Linseed meal, corn meal, wheat bran, wheat middlings, alfalfa meal, meat scraps.
6861	Stephen Holland & Sons, Hornell, N. Y. " Holland's Dry Mash "	Hornell	G 18.	4.50	11.	Ground oats, corn meal, ground bone, dried milk, ground barley, meat scraps, ground charcoal, linseed meal, alfalfa meal, wheat middlings, cottonseed meal, corn gluten feed, wheat bran, small amount of salt.
			F 19.4	4.6	7.7	As certified.

6226	Stephen Hollands & Sons, Hornell, N. Y. " Hollands Soft Poultry Food "	Hornell	G 13.	4.50	13.	Corn meal, ground barley, ground oats, ground bone, wheat bran, gluten feed, cottonseed meal, meat scraps, linseed meal, alfalfa meal, granulated charcoal, wheat middlings, salt and dried milk.
			F 19.5	4.6	8.	Corn meal, small amount of ground barley, ground oats, ground bone, wheat bran, wheat middlings, corn gluten feed, cottonseed meal, alfalfa meal, charcoal, dried casein, salt, meat scraps and linseed meal.
6921	The H. O. Company, Buffalo, N. Y. " The H-O Co's Algrane Scratching Feed for Poultry "	Poughkeepsie	G 11.	3.50	9.	Wheat, oats, kaffir corn, buckwheat, wheat screenings, cracked corn, milo maize, sunflower seed, hulled oats.
			F 11.8	3.4	2.5	Wheat, oats, kaffir corn, buckwheat, wheat screenings, cracked corn, milo maize, barley, oat groats.
6896	The H. O. Company, Buffalo, N. Y. " The H-O Co's Steam Cooked Chick Feed "	Syracuse	G 12.	3.	9.	Cracked corn, cut oat meal, cracked wheat, cracked kaffir corn, cracked peas, millet.
			F 12.4	3.9	1.5	Cracked corn, oat groats, cracked wheat, cracked kaffir corn, cracked peas, millet and weed seeds.
7464	The H-O Mills, Buffalo, N. Y. " The H-O Co's Chick Feed "	York	G 12.	3.	9.	Cracked corn, cut oat meal, cracked wheat, cracked kaffir corn, cracked peas, millet.
			F 13.	3.8	2.1	Cracked corn, oat groats, cracked wheat, cracked kaffir corn, cracked peas, millet and weed seeds.
7183	The H-O Co., Buffalo, N. Y. " The H-O Co's Dry Poultry Mash "	Amenia	G 18.	3.50	9.	Oat midds, gluten feed, wheat midds, rolled oats, alfalfa, corn, hominy feed, cracked wheat, wheat bran.
			F 19.3	4.1	10.8	Alfalfa meal, cracked wheat, corn, hominy feed, corn gluten feed, oat middlings, wheat middlings, rolled oats, salt.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7206	The H-O Co., Buffalo, N. Y. "The H-O Co's Poultry Feed"	Troy	G* 17.	4.50	9.	Ground corn, corn starch by-product with bran, wheat midds, oat midds, wheat bran, hominy feed, rolled oats.
			F* 18.1	4.9	6.2	Ground corn, corn gluten feed, wheat bran, wheat middlings, hominy feed, oat middlings, rolled oats.
7250	International Sugar Feed Co., Minneapolis, Minn. "International Poultry Feed"	Monroe	G 10.	3.50	5.	Corn, wheat, oats, barley, kaffir corn or milo maize, buckwheat, sunflower seed.
			F 11.6	3.5	3.1	Cracked corn, wheat, oats, barley, milo maize, kaffir corn, buckwheat, sunflower seeds.
6775	F. L. Jennings, Elmira, N. Y. "Reliable Mash"	Elmira	G 20.28	5.75	6.25	Wheat bran, middlings, corn meal, alfalfa meal, beef scrap, oil meal, oat flake and charcoal.
			F 20.8	5.4	6.	Wheat bran, wheat middlings, corn meal, alfalfa meal, beef scraps, linseed meal, rolled oats, charcoal.
7483	Mystic Milling & Feed Co., Rochester, N. Y. "Mystic Growing Mash"	Rochester	G 14.	8.	8.	Wheat bran, wheat middlings, corn meal, corn gluten feed, alfalfa meal, bone meal and meat meal.
			F 14.9	3.7	3.4	As certified.

6359	Mystic Milling & Feed Co., Rochester, N. Y. "Mystic Laying Mash"	Rochester	G 23.	4.	8.	Wheat middlings, wheat bran, corn meal, corn gluten feed, oil meal, alfalfa meal, blood meal, bone meal, meat meal.
			F 23.3	4.9	6.3	Wheat bran, wheat middlings, corn meal, corn gluten feed, linseed meal, alfalfa meal, meat meal, blood meal, bone meal.
6497	A. Nowak & Son, Buffalo, N. Y. "Lay-Egg-O Dry Mash"	Schenectady	G 12.	3.	4.	Corn feed meal, corn gluten feed, wheat bran, wheat middlings and heneta (phosphorus, lime, sodium and silica).
			F 13.4	4.1	4.3	Corn feed meal, corn gluten feed, wheat bran, wheat middlings, heneta grit.
5569	Wm. Orr & Sons, Orr's Mills, N. Y. "Orr's Digestible Mash"	New York City	G 12.	3.	10.	Wheat bran, corn meal, fish scrap, meat scrap, wheat middlings, ground oats, ground barley, dried beet pulp, alfalfa meal, buckwheat midds, mustard bran, alpha meal, salt, old process linseed oil meal, corn gluten feed.
			F 20.7	4.3	6.	Wheat bran, wheat middlings, corn meal, meat scraps, ground oats and barley, dried beet pulp, alfalfa meal, buckwheat middlings, mustard hulls, linseed meal, corn gluten feed, salt.
7525	Park & Pollard Co., Boston, Mass. "Dry-Mash"	Seneca Falls	G 18.	3.50	12.	Ground:—wheat bran, wheat middlings, corn, wheat, oats, barley, kaffir corn, buckwheat, alfalfa, fish, meat, bone, beet pulp, calcium carbonate and salt.
			F 20.9	3.5	6.6	Wheat bran, wheat middlings, ground corn, wheat, oats, barley, buckwheat, alfalfa meal, fish scraps, meat meal, bone meal, grit, salt, traces of kaffir corn and beet pulp.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
6938	The Park & Pollard Co., Boston, Mass. " Gritless Chick Feed "	Beacon	G* 11.	3.50	5.	Cracked corn, wheat, kaffir corn and milo, whole millet seed and shredded fish.
			F* 14.3	3.8	1.4	Cracked corn, wheat, small amount of kaffir corn and milo maize, millet, fish scrap.
7677	Park & Pollard Co., Boston, Mass. " Growing Feed "	Rome	G 10.	3.5	8.	Ground corn, wheat, barley, oats, meat, bone, alfalfa, kaffir corn, wheat bran, wheat middlings, buckwheat, beet pulp, calcium carbonate and salt.
			F 14.9	3.4	3.7	Ground corn, wheat, barley, oats and buckwheat, meat and bone meal, wheat bran, wheat middlings, calcium carbonate, salt and traces of alfalfa, kaffir corn and beet pulp.
7524	Park & Pollard Co., Boston, Mass. " Margaret Mahaney's Turkey Feed "	Seneca Falls	G 10.	3.50	12.	Ground:—wheat, barley, linseed oil meal, oats, meat, bone, calcium hydroxide, calcium carbonate and salt.
			F 14.7	2.3	6.5	Ground wheat, barley and oats, meat and bone meal, linseed meal, calcium hydroxide, calcium carbonate, small amounts of ground corn and weed seeds, salt.
6256	D. V. Personius & Son, Waverly, N. Y. " Improved Dry Mash "	Waverly	G 12.	3.	9.	Corn meal, wheat middlings, wheat bran, alfalfa meal, oil meal, beef scrap, bone and meat, meal and salt.
			F 18.4	4.6	5.2	Corn meal, wheat middlings, alfalfa meal, corn gluten meal, meat and bone meal, salt.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
6957	The Quaker Oats Company, Chicago, Ill. "Schumacher Little Chick Feed"	Homer	G* 10.	2.50	5.	Cracked Indian corn, whole millet seed, cracked kaffir corn, cracked wheat, oat meal, ground charcoal, marble grit.
			F* 10.1	3.4	2.1	Fine cracked corn, millet seed, cracked kaffir corn, cracked wheat, oat groats, ground charcoal, marble grit, flaxseed, charlock, foxtail, pigweed, wild buckwheat.
7171	The Quaker Oats Company, Chicago, Ill. "Schumacher Scratching Grains"	Pawling	G 10.	2.50	5.	Made from whole wheat, whole kaffir corn, whole barley, cracked Indian corn, whole buckwheat, sunflower seed.
			F 11.3	3.6	2.2	Wheat, kaffir corn, barley, buckwheat, oats, sunflower seeds, cracked corn.
6911	Ralston Purina Co., St. Louis, Mo. "Purina Chick Feed"	Poughkeepsie	G 11.	3.	4.	Wheat, corn, millet, kaffir or milo maize, recleaned wheat screenings.
			F 10.6	3.6	2.4	Cracked wheat, corn and kaffir corn, millet and weed seeds.
6774	Fred Smith, Elmira, N. Y. "Smith's Special Poultry Mash"	Elmira	G 15.	5.	7.	Wheat bran, wheat middlings, corn meal, oil meal, alfalfa meal, ground oats, gluten, beef scraps.
			F 17.1	5.5	6.4	Wheat bran, wheat middlings, corn meal, linseed meal, alfalfa meal, ground oats, corn gluten feed, beef scraps.

7000	Spratt's Patent (America) Ltd., Newark, N. J. " Chick Meal "	Oxford	G 20.	2.50	2.	Wheat flour and meat.
			F 22.2	2.4	.8	Ground bread, meat, bone and mustard seed.
6927	Spratt's Patent (America) Ltd., Newark, N. J. " Spratt's Egg Mash Food "	Poughkeepsie	G 24.	4.50	8.	Wheat bran, wheat, corn meal, alfalfa meal, ground meat, ground rice, ground kaffir corn, ground buckwheat, ground bone, ground charcoal, ground peas.
			F 23.8	5.7	5.2	Wheat bran, wheat middlings, corn meal, alfalfa meal, meat meal, ground rice, ground kaffir corn, ground buckwheat, ground bone, charcoal, pea meal.
7481	Stephen Holland & Sons, Hornell, N. Y. " Holland's Dry Mash "	Hornell	G 18.	4.50	11.	Ground oats, corn meal, ground bone, dried milk, ground barley, meat scraps, ground charcoal, linseed meal, alfalfa meal, wheat middlings, cottonseed meal, corn gluten feed, wheat bran, small amount of salt.
			F 19.5	4.7	7.6	As certified.
5739	Syracuse Milling Co., Syracuse, N. Y. " Dry Mash (Syragold) "	Canajoharie	G 12.	3.	5.	Wheat bran, wheat middlings, yellow corn meal, gluten feed, old process oil meal, heneta.
			F 12.3	3.	4.5	Wheat bran, wheat middlings, corn meal, corn gluten feed, linseed meal, heneta grit.
6818	Syracuse Milling Co., Syracuse, N. Y. " Syragold Dry Mash "	Lafargeville	G 12.	3.	5.	Wheat bran, wheat middlings, yellow corn meal, gluten feed, old process oil meal, heneta.
			F 12.2	3.2	4.4	Wheat bran, wheat middlings, corn meal, corn gluten feed, linseed meal, heneta grit.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
6994	Syracuse Milling Co., Syracuse, N. Y. " Syragold Dry Mash "	Wampsville	G* 12.	3.	5.	Wheat bran, wheat middlings, yellow corn meal, corn gluten feed, old process linseed meal, hen-e-ta.
			F* 11.9	2.8	4.	Wheat bran, wheat middlings, corn meal, corn gluten feed, linseed meal, heneta grit.
6255	W. I. Teed's Sons, Sayre, Pa. " Teed's Ready-Mixed Laying Mash "	Waverly	G 18.	4.	8.	Gluten meal, white middlings, corn meal, beef scrap, oil meal, salt, wheat bran, ground oats, alfalfa meal and charcoal.
			F 18.7	5.1	6.9	Wheat bran, wheat middlings, corn meal, corn gluten meal, linseed meal, meat and bone scrap, ground oats, alfalfa meal, charcoal, salt.
6622	Tioga Mill & Elevator Co., Waverly, N. Y. " Tioga Dry Mash "	Glens Falls	G 13.	3.75	5.25	Corn meal, corn germ, linseed meal, wheat flour, wheat bran, gluten feed, wheat middlings, kaffir corn meal, phospho-silicate of lime and soda.
			F 13.2	2.5	3.6	Corn meal, corn germ, linseed meal, wheat bran, wheat middlings, wheat flour, corn gluten feed, kaffir corn meal, heneta grit.
7234	L. R. Wallace, Middletown, N. Y. " Mapes Balanced Ration for Poultry "	Florida	G 12.	4.	8.	Animal meal, ground bone, corn meal, wheat middlings, wheat bran, corn gluten feed, ground oats and alfalfa meal.
			F 13.2	3.3	3.8	Corn meal, wheat bran, wheat middlings, meat meal, bone meal, ground oats, alfalfa meal, traces of wheat, kaffir corn and ground oyster shells.

	CALF MEALS:					
6912	The Blatchford Calf Meal Factory, Waukegan, Ill. "Blatchford's Calf Meal"	Poughkeepsie	G 24.	5.	6.75	Locust bean meal, unpressed flaxseed, wheat flour, barley meal, ground beans and peas, old process oil meal, cocoa shell meal, cocoanut meal, recleaned cottonseed meal, fenugreek, dried milk, anise, salt.
			F 25.9	5.8	7.2	Locust bean meal, bean meal, pea meal, flaxseed meal, wheat flour, linseed meal, ground cocoa shells, cocoanut meal, cottonseed meal, fenugreek, dried milk, salt, barley starches also identified.
7427	Clover Leaf Milling Co., Buffalo, N. Y. "Clover Leaf Calf Meal"	South Byron	G 25.	7.	7.	Flour, wheat flour, pulverized malt, linseed meal, cottonseed meal and a small percentage of salt.
			F 28.5	5.2	6.8	As certified.
5875	International Stock Food Co., Minneapolis, Minn. "Grofast Calf Meal"	Chateaugay	G 25.	5.	10.	Fenugreek seed, locust bean, linseed oil meal, dried brewers' grains, flaxseed, gluten feed, malt sprouts, pea meal, distillers' dried grains, cleaned grain screenings, red dog flour.
			F 25.8	6.	8.	Fenugreek, locust bean meal, linseed meal, red dog flour, ground screenings containing flax, oats and barley.
6869	International Stock Food Co., Minneapolis, Minn. "Grofast Calf Meal"	Norwich	G 25.	5.	10.	Fenugreek seed, locust bean, linseed oil meal, dried brewers' grains, flaxseed, gluten feed, malt sprouts, pea meal, distillers' dried grains, cleaned grain screenings, red dog flour.
			F 26.6	6.9	7.8	Fenugreek, locust bean meal, linseed meal, red dog flour, ground grain screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	CALF MEALS, (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
7106	International Stock Food Co., Minneapolis, Minn. " Grofast Calf Meal "	Walton	G*25.	5.	10.	
			F* 26.9	6.7	7.8	Fenugreek, locust bean meal, linseed meal, red dog flour, ground grain screenings containing flax, oats and barley.
7410	International Stock Food Co., Minneapolis, Minn. " Grofast Calf Meal "	Attica	G 25.	5.	10.	Fenugreek seed, locust bean, linseed oil meal, dried brewers' grains, cottonseed meal, flaxseed, gluten feed, malt sprouts, pea meal, distillers' dried grains, cleaned grain screenings, red dog flour.
			F 26.	6.1	7.8	Fenugreek, locust bean meal, linseed meal, cottonseed meal, red dog flour, ground grain and flax screenings.
7224	North West Mills Co., Winona, Minn. " Bill's Calf Meal "	Berlin	G 25.	6.	6.	Made of pulverized wheat, pulverized malt, linseed meal and cottonseed meal.
			F 24.4	5.5	4.	As certified.
7738	The Quaker Oats Company, Chicago, Ill. " Gregson Calf Feed "	Schuylerville	G 25.	5.	5.	Made from oatmeal, barley, linseed, cottonseed and three-fourths of one per ct. salt.
			F 25.3	6.3	5.2	Oat meal, barley product, linseed meal, cottonseed meal, fenugreek, salt.
6684	The Quaker Oats Company, Chicago, Ill. " Schumacher Calf Meal "	Barneveld	G 19.	8.	3.	Made from oat meal, wheat meal, ground flaxseed, dried casein, cottonseed meal, one-half of one per ct. bicarbonate soda.
			F 20.2	8.9	2.3	As certified.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	ANIMAL PRODUCTS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7736	Cyphers Incubator Co., New York, N. Y. "Cyphers High Protein Meat Scraps for Poultry"	Mt. Kisco	G* 45. F* 52.1	10. 17.4	— —	Meat and bone scrap.
6367	Darling & Company, Chicago, Ill. "Darling's Meat Crisps"	Palmyra	G 75. F 75.7	.50 9.1	3. —	Sweet meat trimmings, carefully cooked, pressed and dried. Meat scraps.
7304	Jacob Dold Packing Co., Buffalo, N. Y. "Dold Quality Digester Tankage"	Buffalo	G 60. F 64.9	8. 11.1	— —	Digester tankage.
7305	Jacob Dold Packing Co., Buffalo, N. Y. "Dold Quality Meat Meal"	Buffalo	G 46. F 49.9	10. 12.6	— —	Meat and bone meal.
6149	Jacob Dold Packing Co., Buffalo, N. Y. "Dold Quality Meat Scrap"	Owego	G 50. F 53.3	8. 9.9	5. —	Meat and bone scrap. Meat and bone scrap.
7286	Jacob Dold Packing Co., Buffalo, N. Y. "Dold Quality Soluble Blood Flour"	Buffalo	G 85. F 85.	— —	5. —	Blood meal.
5276	R. D. Eaton Grain & Feed Co., Norwich, N. Y. "Eaton's High Grade Beef Scrap	Norwich	G 50. F 47.7	8. 10.4	2. —	Beef scrap. Meat and bone scrap.

6878	George M. Finn, Syracuse, N. Y. " Ground Beef and Bone Scrap Chicken Feed "	Casenovia	G	35.	15.	——	
			F	40.4	21.9	——	Meat and bone scrap.
5804	The Flavell Company, Asbury Park, N. J. " V. I. M. Pure Beef Cracklings "	Cortland	G	50.	15.	3.	
			F	49.9	17.6	——	Meat and bone scrap.
7155	The L. T. Frisbie Co., New Haven, Conn. " Frisbie's Poultry Food "	Stormville	G	40.	8.	——	Prepared from cooked meat and bone scrap.
			F	41.	11.2	——	Meat and bone scrap.
6631	Hinckley Rendering Co., Somersville, Mass. " Beef Scrap "	Greenwich	G	——	——	——	
			F	35.5	10.6	——	Meat and bone scrap.
6867	Lowell Fertilizer Co., Boston, Mass. " Lowell Poultry Food "	Sherburne	G	40.	8.	——	Prepared from cooked meat and bone scraps.
			F	48.1	11.5	——	Meat and bone scraps.
7212	Lowell Fertilizer Co., Boston, Mass. " Lowell Bone and Meat Meal for Poultry and Hogs "	Saratoga Springs	G	35.	8.	——	
			F	49.8	9.4	——	Meat and bone meal.
7539	Martin R. Maurer, Elizabeth, N. J. " Quality Meat and Bone Scraps "	Clyde	G	50.	10.	——	
			F	51.3	14.7	——	Meat and bone scrap.
6441	L. Newhof & Son., Albany, N. Y. " Poultry Food "	Albany	G	35.	10.	——	
			F	37.5	12.6	——	Meat and bone meal.
5684	The Park & Pollard Company, Boston, Mass. " Blue Ribbon Meat Scraps "	Sidney	G	45.	13.	2.	
			F	44.1	13.5	——	Meat and bone scrap.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	ANIMAL PRODUCTS (*continued*):		*Per ct.*	*Per ct.*	*Per ct*	
6963	Quaker City Mfg. Co., Philadelphia, Pa. " Quaker City Brand Beef Scraps "	Newark Valley	G* 50. F* 46.5	10. 15.1	2. ——	Meat and bone scrap.
7227	Robert A. Reichard, Allentown, Pa. " Reichard's Standard Beef Scrap "	New Hampton	G 45. F 48.9	8. 15.2	5. ——	Meat and bone scrap.
7251	Spratt's Patent (America) Ltd., Newark, N. J. " Spratt's Ground Meat "	Jamestown	G 43. F 43.9	11. 11.6	2. ——	Ground meat. Meat and bone meal.
6478	H. M. Stanton, Schenectady, N. Y. " Ground Beef Scraps "	Albany	G 40. F 39.	15. 23.2	—— ——	Meat and bone scrap.
5265	Swift & Co., Newark, N. J. " Swift's Eureka Meat Scraps "	Oxford	G 50. F 50.4	8. 12.45	3. ——	Meat scraps. Meat and bone scrap.
5264	Swift & Company, Newark, N. J. " Swift's Laymore Meat Scraps "	Oxford	G 40. F 41.1	8. 12.1	3. ——	Meat scraps. Meat and bone scrap.
6871	Swift & Company, Newark, N. J. " Swift's Meat Scraps "	Earlville	G 50. F 51.6	8. 11.4	3. ——	Meat and bone scrap.
6974	Syracuse Rendering Co., Syracuse, N. Y. " Syracuse Bone and Meat Meal for Poultry "	Cincinnatus	G 35. F 35.7	8. 8.2	—— ——	Bone and meat. Meat and bone meal.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	ANIMAL PRODUCTS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
5600	F. A. Van Iderstine & Son, Brooklyn, N. Y. " High Protein Meat and Bone Scrap for Poultry "	Brooklyn	G* 50. F* 50.2	10.0 18.3	—— ——	Meat and bone scrap.
	FISH SCRAPS:					
6999	International Glue Co., Boston, Mass. " Red Star Brand Fish Scrap "	Oxford	G 45. F 43.7	2. 2.3	—— ——	Fish scrap. As certified.
	ALFALFA MEALS:					
6971	American Milling Co., Chicago, Ill. " Amco Alfalfa Meal "	Endicott	G 13. F 14.8	2. 1.5	30. 28.5	Alfalfa hay. Alfalfa meal.
6299	J. D. Braue, Inc., Jordan, N. Y. " Braue's Alfalfa Meal "	Jordan	G 14. F 17.	2. 2.1	28. 23.6	Alfalfa meal.
7153	The Denver Alfalfa Milling & Products Co., Hartman, Colo. " Colorado Alfalfa Meal "	Poughkeepsie	G 12. F 13.7	1.50 2.3	35. 27.6	Made from alfalfa hay. Alfalfa meal.
6492	The Albert Dickinson Co., Chicago, Ill. " Alfalfa Meal "	Schenectady	G 12. F 12.7	1. 1.8	35. 29.6	Made from alfalfa hay. Alfalfa meal.
6862	The Albert Dickinson Co., Chicago, Ill. " Alfalfa Meal "	Sherburne	G 12. F 15.3	1. 1.6	35. 28.9	Made from alfalfa hay. Alfalfa meal.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	ALFALFA MEALS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
6626	Arthur E. Pratt Co., Albany, N. Y. " Alfalfa Meal "	Glens Falls	G* —— F* 14.2	—— 1.6	—— 32.2	Alfalfa meal.
6776	Purina Mills, St. Louis, Mo. " Purina Alfalfa Meal "	Penn Yan	G 14. F 17.5	1.5 2.2	29. 24.	Pure alfalfa hay. Alfalfa meal.
8006	Somers & Co., San Francisco, Cal. " Red Star Brand Alfalfa Meal "	Brooklyn	G 16.6 F 16.5	1.4 1.6	29.5 26.4	Alfalfa meal.
6907	The Otto Weiss Alfalfa Stock Food Co., Wichita, Kan. " Pure Dustless Alfalfa Meal "	Poughkeepsie	G 14. F 16.1	1.50 2.	30. 26.7	Alfalfa meal.
6908	The Otto Weiss Alfalfa Stock Food Co., Wichita, Kan. " Pure Dustless Alfalfa Meal "	Poughkeepsie	G 14. F 18.5	1.50 2.5	30. 16.7	Alfalfa meal.
5293	The Wichita Alfalfa Stock Food Co., Wichita, Kan. " Wichita Pure Alfalfa Meal "	Marathon	G 12. F 14.5	1.5 1.6	30. 29.4	Alfalfa meal.
	WHEAT BY-PRODUCTS—WHEAT BRAN AND SCREENINGS:					
7731	Atlas Flour Mills, Milwaukee, Wis. " Atlas Wheat Bran with Ground Screenings not Exceeding Mill Run "	Catskill	G 15. F 15.9	3.50 3.8	12. 9.4	Wheat bran, ground screenings.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BY-PRODUCTS—WHEAT BRAN AND SCREENINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6490	William G. Crocker, Minneapolis, Minn. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Schenectady	G* 14.50 F* 15.6	4. 5.6	12. 9.9	Wheat bran, ground screenings.
7222	Dominion Flour Mills, Ltd., Montreal, Canada. "Pure Bran Feed with Mill Run of Screenings"	Granville	G 15. F 16.5	4.75 5.7	11. 8.2	Wheat bran containing a trace of ground screenings.
7479	Duluth-Superior Milling Co., Duluth, Minn. "Duluth Imperial Bran with Ground Screenings not Exceeding Mill Run"	Canisteo	G 15. F 15.	4. 5.5	11.25 9.9	Wheat bran, ground screenings.
7008	Eagle Roller Mills Co., New Ulm, Minn. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Brewerton	G 15.45 F 15.8	3.43 4.8	11.50 9.8	Wheat bran containing a trace of ground screenings.
5678	B. A. Eckhart Milling Co., Chicago, Ill. "Bran with Ground Screenings"	New York City	G 14. F 16.3	4. 4.7	11. 8.9	Bran with ground screenings not exceeding mill run. Wheat bran, ground screenings.
7777	B. A. Eckhart Milling Co., Chicago, Ill. "Bran with Ground Screenings not Exceeding Mill Run"	Fulton	G 14. F 16.4	4. 4.8	11. 8.4	Wheat bran, ground screenings.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BY-PRODUCTS — WHEAT BRAN AND SCREENINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6343	J. A. Hinds & Co., Rochester, N. Y. " Wheat Bran with Ground Screenings not Exceeding Mill Run "	Rochester	G* 14.5 F* 16.4	4.2 5.6	11.8 8.9	Wheat bran, containing a trace of screenings.
6887	Hubbard Milling Co., Mankato, Minn. " Flaky Bran "	Skaneateles	G 15. F 16.	4.8 5.	11.5 9.7	Wheat bran with ground screenings not exceeding mill run. Wheat bran, ground screenings.
6624	Hunter-Robinson-Wenz Milling Co., St. Louis, Mo. " Wheat Bran with Ground Screenings not Exceeding Mill Run "	Glens Falls	G 15.50 F 17.9	4. 4.9	11. 8.8	Wheat bran containing a trace of ground screenings.
6630	The Kaw Milling Co., Topeka, Kans. " Wheat Bran and Screenings "	Greenwich	G 17. F 17.5	4. 4.8	9.6 9.	Not to exceed 8 per ct. screenings. Wheat bran containing a trace of ground screenings.
6263	Kemper Mill & Elevator Co., Kansas City, Mo. " Anchor Bran with Ground Wheat Screenings not Exceeding Mill Run "	Truxton	G 14.50 F 14.8	4. 4.9	10. 8.4	Wheat bran, containing a trace of screenings.
7802	Kemper Mill & Elevator Co., Kansas City, Mo. " Diamond K Bran with Ground Wheat Screenings not Exceeding Mill Run "	Itaska	G 14.50 F 16.9	4. 4.6	10. 8.7	Made from pure wheat. Wheat bran containing traces of ground screenings.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BY-PRODUCTS — WHEAT BRAN AND SCREENINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6280	Peninsular Milling Co., Flint, Mich. " Wheat Bran and Screenings "	Cincinnatus	G* 14. F* 14.9	3. 4.1	12. 9.1	Wheat bran, containing trace of ground screenings.
7433	Pillsbury Flour Mills, Minneapolis, Minn. " Pillsbury's Wheat Bran with Ground Screenings not Exceeding Mill Run "	Brockport	G 14.5 F 16.4	4. 5.2	12. 9.5	Wheat bran containing 1.2 per ct. of Screenings and foreign materials.
5570	Geo. P. Plant Milling Co., St. Louis, Mo. " Wheat Bran with Screenings not Exceeding Mill Run "	New York City	G 15. F 16.6	2. 4.8	10. 8.7	Wheat bran containing traces of ground screenings.
7021	Geo. P. Plant Milling Co., St. Louis, Mo. " Wheat Bran with Screenings not Exceeding Mill Run "	Groton	G 15. F 17.9	3. 4.7	11. 9.1	Wheat bran and screenings.
5582	M. G. Rankin & Co., Milwaukee, Wis. " Wheat Bran with Ground Screenings not Exceeding Mill Run"	New York City	G 14.50 F 17.3	4. 5.1	9.50 8.8	Wheat bran with ground screenings not exceeding mill run. Wheat bran containing approximately 1.4 per ct. of immature and shrunken wheat.
7548	The Southwestern Milling Co., Kansas City, Mo., " Wheat Bran with Ground Screenings not Exceeding Mill Run "	Auburn	G 16.16 F 18.3	3.58 5.4	10.22 9.	Wheat bran containing a trace of ground screenings.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BY-PRODUCTS—WHEAT BRAN AND SCREENINGS (*concluded*).		*Per ct.*	*Per ct.*	*Per ct.*	
7447	Victor Milling Co., Victor, N. Y. "Victor Spring Wheat Bran with Ground Screenings not Exceeding Mill Run"	Canandaigua	G* 14.6 F* 16.1	4. 5.7	15. 10.	Wheat bran containing 4.33 per ct. of screenings and foreign materials.
7494	Voigt Milling Co., Grand Rapids, Mich. "Voigt's Pure Bran Containing Ground Screenings not Exceeding Mill Run"	Johnsonburg	G 17. F 16.4	6.5 4.4	7.5 7.3	Wheat bran containing traces of corn cockle and shrunken rye.
6901	Washburn Mills, Minneapolis, Minn. "Washburn-Crosby Co's Wheat Bran with Ground Screenings not Exceeding Mill Run"	Poughkeepsie	G 14.50 F 14.9	4. 5.5	12. 9.9	Wheat bran, ground screenings.
5805	Western Canada Flour Mills Co., Ltd., Winnipeg, Canada. "Bran and Screenings"	Cortland	G 16.82 F 16.5	5.50 5.	10.86 8.1	Wheat bran, ground screenings.
7474	Western Canada Flour Mills, Ltd., Canada. "Spring Wheat Bran with Ground Screenings not Exceeding Mill Run"	Strykersville	G 16. F 15.7	5. 5.2	10. 8.5	Wheat bran containing approximately 0.5 per ct. of ground screenings.
	WHEAT MIDDLINGS AND SCREENINGS:					
6990	Ames-Burns Co., Jamestown, N. Y. "Perfection Fancy Winter Midds with Ground Screenings not Exceeding Mill Run"	Morrisville	G 14. F 17.3	3. 5.7	10. 3.9	Winter midds with ground screenings not exceeding mill run. Wheat middlings, ground screenings.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT MIDDLINGS AND SCREENINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7522	The Birkett Mills, Penn Yan, N. Y. "Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Hayts Corners	G* 15.75 F* 16.6	4. 5.7	5.50 3.8	Wheat by-product. Wheat middlings, ground screenings.
7429	Cataract City Milling Co., Niagara Falls, N. Y. "White Middlings with Ground Screenings not Exceeding Mill Run"	Hilton	G 15.92 F 17.8	5. 5.3	— 5.9	Wheat middlings containing traces of ground screenings.
6822	Claro Milling Co., Lakeville, Minn. "Claro Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Watertown	G 14. F 18.4	3. 6.1	2. 6.4	Wheat middlings, ground screenings.
5877	The Cleveland Milling Co., Cleveland, O. "Wheat Coarse Middlings with Ground Screenings not Exceeding Mill Run"	Burke	G 14. F 18.3	4.50 5.6	9. 6.	Wheat middlings, ground screenings.
7730	The Cleveland Milling Co., Cleveland, O. "Wheat Coarse Middlings with Ground Screenings not Exceeding Mill Run"	Catskill	G 14. F 20.1	4.50 6.	9. 6.3	Wheat middlings containing a small amount of ground screenings.
5878	The Cleveland Milling Co., Cleveland, O. "Wheat Fine Middlings with Ground Screenings not Exceeding Mill Run"	Burke	G 15. F 16.4	3.50 4.5	6. 3.8	Wheat middlings, ground screenings.

6261	Wm. A. Combs Milling Co., Coldwater, Mich. "Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Owego	G 15.	3.	8.	
			F 17.5	4.8	5.9	Wheat middlings, containing a trace of ground screenings.
6772	William G. Crocker, Minneapolis, Minn. "Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Corning	G 17.	5.	6.50	
			F 16.7	5.8	6.8	Wheat middlings, ground screenings.
5284	William G. Crocker, Minneapolis, Minn. "Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	New Berlin	G 15.	5.	9.50	Wheat standard middlings with ground screenings not exceeding mill run.
			F 17.	6.	6.7	Wheat middlings, ground screenings.
7727	Davis Mill Co., Galesville, Wis. "Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Kingston	G 16.10	4.46	6.07	
			F 16.9	4.8	5.0	Wheat middlings, ground screenings.
5559	Duluth Superior Milling Co., Duluth, Minn. "Standard Diamond S Middlings with Ground Screenings not Exceeding Mill Run"	Ballston Spa	G 16.5	5.5	8.	
			F 16.9	5.4	6.3	Wheat middlings, containing a trace of ground screenings.
7480	Duluth-Superior Milling Co., Duluth, Minn. "Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Canisteo	G 16.50	5.50	8.	
			F 18.1	6.	7.1	Wheat middlings.
6890	Everett, Aughenbaugh & Co., Waseca, Minn. "E-A-Co Wheat Middlings"	Skaneateles	G 15.	3.	10.	Standard and flour middlings and ground screenings not exceeding mill run.
			F 18.2	6.	6.7	Wheat middlings, ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT MIDDLINGS AND SCREENINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6294	Federal Milling Co., Lockport, N. Y. "Dairy Maid Winter Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Camillus	G* 15. F* 16.5	5. 4.9	7. 4.1	Wheat middlings, ground screenings.
6821	Federal Milling Co., Lockport, N. Y. "Lucky Spring Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Adams	G 17. F 18.3	5. 6.2	9. 6.	Wheat middlings, containing a trace of ground screenings.
7002	Federal Milling Co., Lockport, N. Y. "Sphinx Fancy Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Canastota	G 17. F 17.6	4.5 5.5	9. 4.4	Wheat middlings, containing traces of ground screenings.
7012	The Gardner Mills, Hastings, Minn. "Snowfall Wheat White Middlings with Ground Screenings not Exceeding Mill Run"	Little York	G 15. F 17.1	4. 5.2	7.5 4.2	Wheat middlings containing traces of ground screenings.
6259	The Harter Milling Co., Toledo, O. "Harter's Winter Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Owego	G 15. F 16.6	4. 5.6	6.50 5.1	Wheat middlings, ground screenings.

7412	Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. "Standard Middlings with Mill Run Screenings"	Attica	G F	17.40 18.1	6.08 6.5	7.62 7.1	Made from pure wheat. Wheat middlings containing a trace of ground screenings.
7218	Hennepin Mill Co., Minneapolis, Minn. "Ben-Hur Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Salem	G F	15. 16.3	5. 5.4	9.50 6.8	Wheat middlings, ground screenings.
6344	J. A. Hinds & Co., Rochester, N. Y. "Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Rochester	G F	17.5 18.6	5.3 6.5	7.5 5.	Wheat middlings.
7438	J. A. Hinds & Co., Rochester, N. Y. "Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Macedon	G F	17.5 20.	5.3 5.2	7.5 4.4	Wheat middlings.
7719	Keusch & Schwarts Co., Inc., New York. "K & S Wheat Middlings and Mill Run Screenings"	Rosendale	G F	15. 19.1	5. 4.6	9.50 7.5	Wheat and mill run screenings. Wheat middlings, ground screenings.
8005	The Larabee Flour Mills Co., Clinton, Mo. "Wheat Shorts with Mill Run Screening not to Exceed 8 Per Cent"	Brooklyn	G F	16. 19.7	3.5 5.5	5.5 4.	Wheat middlings containing traces of ground screenings.
6298	Madelia Roller Mills, C. S. Christensen Co., Madelia, Minn. "Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	East Syracuse	G F	14.75 16.1	4.05 5.9	9.25 8.1	Wheat middlings, ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT MIDDLINGS AND SCREENINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6355	Maple Leaf Milling Co., Ltd., Canada. " Fancy Canadian Middlings with Ground Screenings not Exceeding Mill Run "	Dansville	G* 16.	5.50	10.	Wheat middlings, ground screenings.
			F* 17.3	5.5	6.6	
6988	Maple Leaf Milling Co., Canada. " Rex Middlings "	Conklins	G 16.	5.50	10.	With ground screenings not exceeding mill run.
			F 17.6	5.2	6.6	Wheat middlings, ground screenings.
8015	Marshall Milling Co., Marshall, Minn. " Wheat Shorts with Ground Screenings not Exceeding Mill Run "	Albany	G 17.	5.04	9.44	Wheat middlings containing traces of ground screenings.
			F 16.8	5.6	7.5	
6260	Geo. Q. Moon & Co., Binghamton, N. Y. " Fresh Ground Middlings, Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run "	Campville	G 17.5	5.3	7.5	Wheat middlings, containing a trace of ground screenings.
			F 17.2	4.9	3.2	
7102	Morris Bros., Oneonta, N. Y. " Delaware Feed "	Walton	G ——	——	——	Wheat bran, wheat middlings, traces of ground screenings.
			F 16.4	4.8	6.9	
7720	Moseley & Motley Milling Co., Rochester, N. Y. " Wheat Middlings with Ground Screenings not Exceeding Mill Run "	Rosendale	G 15.	4.50	10.	Wheat middlings, ground screenings.
			F 17.	5.3	4.5	

7208	The Northwestern Consolidated Milling Co., Minneapolis, Minn. " Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run "	Ballston	G	15.	4.50	10.	
			F	15.5	5.5	8.5	Wheat middlings, ground screenings.
7217	The Northwestern Consolidated Milling Co., Minneapolis, Minn. " Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run "	Cambridge	G	15.50	4.50	6.	
			F	16.5	5.1	5.5	Wheat middlings, ground screenings.
6975	The Northwestern Consolidated Milling Co., Minneapolis, Minn. " Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run "	Cincinnatus	G	15.	4.50	10.	Wheat standard middlings with ground screenings not exceeding mill run.
			F	16.1	5.6	7.6	Wheat middlings, ground screenings.
6281	Peninsular Milling Co., Flint, Mich. " Wheat Middlings with Ground Screenings not Exceeding Mill Run "	Cincinnatus	G	16.	4.	7.	
			F	17.9	5.7	4.8	Wheat middlings containing a trace of ground screenings.
7734	Pillsbury's Flour Mills, Minneapolis, Minn. " Pillsbury's Wheat A Middlings "	Mt. Kisco	G	15.	4.5	7.	Composed of standard B middlings and low grade flour with ground screenings not exceeding mill run.
			F	16.9	5.	4.9	Wheat middlings, low grade flour, ground screenings.
6955	Pillsbury Flour Mills, Minneapolis, Minn. " Pillsbury's Wheat Standard B Middlings with Ground Screenings not Exceeding Mill Run "	Tully	G	15.	4.50	10.	Wheat standard B middlings with ground screenings not exceeding mill run.
			F	15.9	5.4	9.1	Wheat middlings, containing a trace of ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	WHEAT MIDDLINGS AND SCREENINGS (*conctinued*):					
7020	Geo. P. Plant Milling Co., St. Louis, Mo.		G* 17.	4.	6.50	
	"Wheat Middlings with Screenings not Exceeding Mill Run"	Groton	F* 19.6	5.2	6.	Wheat middlings, containing traces of ground screenings.
8019	Sleepy Eye Flour Mills Co., Minneapolis, Minn.		G 17.2	4.3	9.4	
	"Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Troy	F 17.1	5.5	8.6	Wheat middlings, ground screenings.
7228	Star & Cresent Milling Co., Chicago, Ill.		G 16.	4.	8.	Wheat middlings with ground screenings not exceeding mill run.
	"Star Middlings"	Petersburg	F 16.9	5.3	6.6	Wheat middlings, ground screenings.
6628	Thompson Milling Co., Lockport, N. Y.		G 15.	4.	10.	
	"Angelus Middlings with Ground Screenings not Exceeding Mill Run"	Hudson Falls	F 17.4	5.2	6.7	Wheat middlings, ground screenings.
6491	Thompson Milling Company, Lockport, N. Y.		G 15.	4.	10.	
	"Angelus Middlings with Ground Screenings not Exceeding Mill Run"	Schenectady	F 16.6	5.9	6.1	Wheat middlings, ground screenings.
7401	Thompson Milling Co., Lockport, N. Y.		G 15.	4.	10.	
	"Angelus Middlings with Ground Screenings not Exceeding Mill Run"	Batavia	F 16.1	5.4	5.5	Wheat middlings, containing a trace of ground screenings

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	WHEAT MIDDLINGS AND SCREENINGS (*concluded*):					
6480	Washburn-Crosby Co., Minneapolis, Minn. "Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Albany	G* 17.	5.	6.50	
			F* 17.7	5.5	4.6	Wheat middlings, ground screenings.
6807	Washburn-Crosby Co., Minneapolis, Minn. "Wheat Standard Middlings"	Carthage	G 15.	5.	9.50	Wheat middlings with ground screenings not exceeding mill run.
			F 16.5	6.1	6.9	Wheat middlings, ground screenings.
6346	Washburn Mills, Minneapolis, Minn. "Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Attica	G 15.	5.	9.50	
			F 17.4	6.1	6.8	Wheat middlings, contains a trace of screenings.
	WHEAT BRAN, WHEAT MIDDLINGS, GROUND SCREENINGS:					
7009	Ames Burns Co., Jamestown, N. Y. "Perfection Extra Fancy Winter Bran"	Brewerton	G 14.	4.	10.	
			F 15.4	4.8	7.7	Wheat bran, wheat middlings, traces of ground screenings.
7361	Bill Bell & Co., Ogdensburg, N. Y. "Wise King Wheat Mixed Feed with Ground Screenings"	Ogdensburg	G 16.	5.25	8.50	
			F 16.7	4.9	7.5	Wheat bran, wheat middlings, ground screenings.
7809	Cavalier Milling Co., Cavalier, N. Dak. "Unadulterated Wheat Mixed Feed"	Owego	G 14.	4.5	10.	
			F 15.1	5.5	7.1	Wheat bran, wheat middlings, traces of ground screenings.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BRAN, WHEAT MIDDLINGS, GROUND SCREENINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6257	The Harter Milling Co., Toledo, O. "Harter's Pure Spring Wheat Mixed Feed with Ground Screenings not Exceeding Mill Run"	Owego	G* 15.	4.	8.	
			F* 16.8	5.	6.3	Wheat bran, wheat middlings, ground screenings.
6258	The Harter Milling Co., Toledo, O. "Harter's Winter Wheat Mixed Feed with Ground Screenings not Exceeding Mill Run.	Owego	G 15.	4.	8.	
			F 15.9	5.3	6.5	Wheat bran, wheat middlings, ground screenings.
6690	The Harter Milling Co., Toledo, O. "Harter's Spring Wheat Mixed Feed with Ground Screenings not Exceeding Mill Run"	Newport	G 15.	4.	8.	
			F 16.5	5.2	6.1	Wheat bran, wheat middlings, ground screenings.
7101	Hunter-Robinson-Wenz Milling Co., St. Louis, Mo. "Certified Extra Heavy Mixed Feed"	Roscoe	G 14.50	4.	8.	Wheat bran and middlings with ground screenings not exceeding mill run.
			F 16.9	5.1	7.3	Wheat bran, wheat middlings, traces of ground screenings.
7107	Hunter-Robinson-Wenz Milling Co., St. Louis, Mo. "Certified Extra Heavy Mixed Feed"	Roxbury	G 15.50	4.	10.	Wheat bran and middlings with ground screenings not exceeding mill run.
			F 16.8	4.7	7.8	Wheat bran, wheat middlings, traces of ground screenings.
7024	Hunter-Robinson-Wenz Milling Co., St. Louis, Mo. "Sunshine Choice Mixed Feed"	Norwich	G 15.50	4.	10.	Wheat bran and middlings with ground screenings not exceeding mill run.
			F 18.1	4.5	6.3	Wheat bran, wheat middlings, and a small amount of shrunken wheat.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BRAN, WHEAT MIDDLINGS, GROUND SCREENINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6954	Noblesville Milling Co., Noblesville, Ind. "Good Catch Feed"	Tully	G* 15.	4.	11.	Pure wheat feed, bran, middlings and ground wheat screenings.
			F* 16.8	5.7	7.3	Wheat bran, wheat middlings, ground screenings.
6252	The Northwestern Consolidated Milling Co., Minneapolis, Minn. "Wheat Mixed Feed"	Baldwinsville	G 15.	4.50	10.	Wheat bran, flour middlings and ground screenings not exceeding mill run.
			F 16.6	5.5	6.8	Wheat bran, wheat middlings, ground screenings.
6282	Peninsular Milling Co., Flint, Mich. "Wheat Mixed Feed"	Cincinnatus	G 15.	3.50	9.	
			F 16.6	5.0	6.3	Wheat bran, wheat middlings and a trace of ground screenings.
7689	Rush City Milling Co., Rush City, Minn. "Radisson Mixed Feed"	Wellsbridge	G 13.3	4.4	9.9	
			F 16.3	4.7	6.4	Wheat bran and wheat middlings containing approximately 0.83 per ct. ground screenings
6262	Shane Bros. & Wilson Co., Hastings, Minn. "King Midas Wheat Mixed Feed with Ground Screenings not Exceeding Mill Run"	Homer	G 15.	4.	9.5	
			F 16.6	6.8	5.7	Wheat bran, wheat middlings and a trace of ground screenings.
7708	Shane Bros. & Wilson Co., Hastings, Minn. "King Midas Mixed Feed with Ground Screenings not Exceeding Mill Run"	Chester	G 14.5	4.	9.5	
			F 16.1	4.8	5.2	Wheat bran, wheat middlings and a small amount of ground screenings.

7152	Sparks Milling Co., Alton, Ill. "Try-Me Mixed Feed"	Poughkeepsie	G	15.	3.75	10.	Wheat bran and wheat middlings.
			F	17.9	4.7	6.6	Wheat bran, wheat middlings.
7273	Sparks Milling Co., Alton, Ill. "Try-Me Winter Mixed Feed"	Springville	G	16.	3.5	8.	Pure wheat bran, middlings and ground screenings not exceeding mill run.
			F	16.4	5.	6.9	Wheat bran, wheat middlings, a small amount of ground screenings.
7018	Sparks Milling Co., Terre Haute, Ind. "Wabash Mixed Feed"	Cincinnatus	G	14.	3.5	11.	Composed of wheat bran, wheat middlings and ground wheat screenings not exceeding mill run.
			F	16.2	4.7	7.1	Wheat bran, wheat middlings, ground screenings.
7015	F. W. Stock & Sons, Hillsdale, Mich. "Monarch Fancy Wheat Feed with Mill Run Screenings"	Cortland	G	16.	4.	10.	
			F	16.9	5.2	7.2	Wheat bran, wheat middlings, ground screenings.
7751	F. S. Stock & Sons, Hillsdale, Mich. "Monarch Fancy Wheat Feed"	Mexico	G	16.	4.	10.	
			F	16.6	5.4	7.4	Wheat bran, wheat middlings, ground screenings.
5560	F. W. Stock & Sons, Hillsdale, Mich. "Superior Wheat Feed and Flour with Mill Run Screenings"	Kingston	G	16.	4.50	7.	
			F	15.9	4.5	5.7	Wheat bran, wheat middlings, ground screenings.
6780	F. W. Stock & Sons, Hillsdale, Mich. "Superior Wheat Feed and Flour with Mill Run Screenings"	Bath	G	16.	4.50	7.	
			F	17.	4.7	5.6	Wheat bran, wheat middlings, ground screenings.
6925	Thompson Milling Co., Lockport, N. Y. "Angelus Mixed Feed with Ground Screenings not Exceeding Mill Run"	Poughkeepsie	G	15.	4.	10.	Bran and middlings (wheat), and ground screenings.
			F	16.	4.9	7.1	Wheat bran, wheat middlings, ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BRAN, WHEAT MIDDLINGS, GROUND SCREENINGS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
7246	Thompson & Mould, Goshen, N. Y. "Mixed Feed"	Monroe	G* 14.	3.5	7.5	Wheat bran, wheat middlings, wheat screenings, corn bran.
			F* 14.7	4.7	7.7	Wheat bran, wheat middlings.
6265	Thornton & Chester Milling Co., Buffalo, N. Y. "T & C Wheat Bran with Ground Screenings not Exceeding Mill Run"	Ithaca	G 14.	3.	——	
			F 16.1	5.2	8.8	Wheat bran, wheat middlings, ground screenings.
6670	Thornton & Chester Milling Co., Buffalo, N. Y. "T & C Wheat Mixed Feed"	Boonville	G 15.	4.5	9.	Wheat mixed feed with ground screenings not exceeding mill run.
			F 16.8	5.7	7.6	Wheat bran, wheat middlings, containing approximately 0.5 per ct. screenings and foreign materials.
6268	Tioga Mill & Elevator Co., Waverly, N. Y. "Omar Mixed Feed"	Ithaca	G 15.	4.	10.	Composed of wheat bran and middlings, may contain ground screenings not exceeding mill run.
			F 16.8	5.3	6.	Wheat bran, wheat middlings, ground screenings.
7674	Tioga Mill & Elevator Co., Waverly, N. Y. "Omar Mixed Feed"	Clinton	G 15.	4.	10.	Wheat bran and middlings. (May contain ground screenings not exceeding mill run.)
			F 16.7	5.	5.6	Wheat bran, wheat middlings, ground screenings.
7658	George Urban Milling Co., Buffalo, N. Y. "Wheat Mixed Feed"	Fort Plain	G 16.	4.	10.5	Wheat mixed feed with ground screenings not exceeding mill run.
			F 16.7	5.4	8.3	Wheat bran, wheat middlings, ground screenings.

6965	Washburn-Crosby Co., Minneapolis, Minn. "Wheat Mixed Feed with Ground Screenings not Exceeding Mill Run"	Owego	G	16.	4.50	9.	Wheat bran, flour middlings and ground screenings not exceeding mill run.
			F	16.7	5.4	7.4	Wheat bran, wheat middlings, ground screenings.
7019	The Williams Bros. Co., Kent, O. "Kent Mixed Feed Winter Wheat"	Groton	G	12.	2.	15.	
			F	16.4	4.8	6.2	Wheat bran, wheat middlings, and traces of corn cockle.
6759	Not given. "Mixed Feed"	Watkins	G	——	——	——	Wheat bran and wheat midds.
			F	18.2	5.7	7.5	Wheat bran, wheat middlings and traces of ground screenings.
	WHEAT BRAN, RED DOG FLOUR, GROUND SCREENINGS:						
7457	D. H. Grandin Milling Co., Jamestown, N. Y. "Red Flag Mixed Feed"	Red Creek	G	15.75	4.50	7.	Red dog low grade flour, wheat bran with mill run screenings, one-half of one per ct. salt.
			F	16.8	4.1	5.7	Wheat bran containing ground screenings, red dog flour, salt.
6672	Northwestern Consolidated Milling Co., Minneapolis, Minn. "Planet Feed"	Boonville	G	16.	4.	8.	A mixture of wheat bran and red dog.
			F	18.2	5.7	6.2	Wheat bran, red dog flour, ground screenings.
6674	Pillsbury's Flour Mills Co., Minneapolis, Minn. "Pillsbury's Fancy Wheat Mixed Feed"	Boonville	G	16.	4.5	9.	Wheat bran and low grade flour with ground screenings not exceeding mill run.
			F	16.7	4.9	6.	Wheat bran, red dog flour, ground screenings.
	WHEAT BRAN, WHEAT MIDDLINGS, RED DOG FLOUR, GROUND SCREENINGS:						
7686	Bay State Milling Co., Winona, Minn. "Winona Fancy Mixed Wheat Feed"	Worcester	G	17.	5.	10.	Wheat bran, middlings and red dog flour with ground screenings from wheat.
			F	17.1	4.9	10.2	Wheat bran, wheat middlings, red dog flour, ground screenings.

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* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BRAN, WHEAT MIDDLINGS, RED DOG FLOUR, GROUND SCREENINGS (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7151	Claro Milling Company, Lakeville, Minn. "Claro Wheat Mixed Feed"	Poughkeepsie	G* 15.	3.	12.	Bran, standard and flour middlings, red dog and ground screenings not exceeding mill run.
			F* 16.6	5.7	7.3	Wheat bran, wheat middlings, red dog flour, ground screenings.
6693	Duluth Superior Milling Co., Duluth, Minn. "Boston Mixed Feed"	Newport	G 16.	4.50	9.5	Wheat bran, middlings and low grade flour.
			F 16.9	5.1	7.9	Wheat bran, wheat middlings, red dog flour, containing approximately 0.8 per ct. of screenings and foreign materials.
6866	Sheffield-King Milling Co., Minneapolis, Minn. "Gold Mine Feed"	Sherburne	G 15.90	4.90	8.98	Bran, shorts, low grade flour, wheat product and pulverized screenings.
			F 16.5	5.3	7.1	Wheat bran, wheat middlings, low grade wheat flour, ground screenings.
	WHEAT MIDDLINGS, RYE MIDDLINGS AND GROUND SCREENINGS:					
5583	Hecker-Jones-Jewell Milling Co., New York, N. Y. "H Middlings with Mill Run of Screenings"	New York City	G 16.46	5.38	7.70	
			F 18.3	5.5	7.	Rye middlings, wheat middlings, traces of ground screenings.
6254	The Quaker Oats Company, Chicago, Ill. "Buckeye Feed"	Waverly	G 15.50	4.50	8.50	Mixed wheat feed with ground screenings not exceeding mill run and rye shorts.
			F 16.8	5.5	7.5	Wheat bran, wheat middlings, ground screenings, rye middlings.

7675	George Urban Milling Co., Buffalo, N. Y. "Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Clinton	G	16.	4.5	9.5	Wheat middlings, rye middlings, ground screenings.
			F	16.7	5.	7.	
	WHEAT BRAN AND CORN BY-PRODUCTS AND SCREENINGS:						
7811	Deposit Milling Co., Deposit, N. Y. "Deposit White Mixed Feed"	Deposit	G	14.	4.	8.	Low grade corn and wheat flour, wheat bran not exceeding mill run screenings.
			F	14.	4.3	5.3	Wheat bran containing traces of ground screenings, low grade wheat and corn flour.
6464	Indiana Milling Co., Terre Haute, Ind. "Standard Spring Wheat Bran and Mill Run Screenings"	Albany	G	14.	4.	11.	
			F	14.4	4.5	11.9	Wheat bran and screenings, ground corn cob.
	RYE FEED (RYE BRAN, RYE MIDDLINGS, GROUND SCREENINGS):						
7740	Barber & Bennett, Albany, N. Y. "Rye Feed with Ground Screenings not Exceeding Mill Run"	Albany	G	13.75	3.	6.50	
			F	13.8	3.3	4.3	Rye bran, rye middlings, ground screenings.
6479	Boutwell Milling & Grain Co., Troy, N. Y. "Rye Feed with Ground Screenings not Exceeding Mill Run"	Albany	G	13.50	3.	6.	
			F	15.7	3.4	3.6	Rye bran, rye middlings and ground screenings.
	BUCKWHEAT PRODUCTS:						
7741	Barber & Bennett, Albany, N. Y. "Buckwheat Feed"	Albany	G	25.	4.50	15.	Buckwheat bran, midds and small portion of hulls.
			F	29.9	7.9	7.8	Buckwheat bran, buckwheat middlings, and a small amount of buckwheat hulls.
6766	Bath Roller Mills, Bath, N. Y. "Buckwheat Feed"	Bath	G	——	——	——	All parts of the buckwheat except the flour.
			F	13.8	3.9	19.	Buckwheat hulls and buckwheat middlings.

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* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	BUCKWHEAT PRODUCTS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6283	The Birkett Mills, Penn Yan, N. Y. "Ground Buckwheat Screenings"	Trumansburg	G* 10.	2.25	15.	Contains light buckwheat, buckwheat chaff and weed seed.
			F* 12.6	2.4	11.7	Ground buckwheat screenings, consisting largely of light buckwheat, buckwheat hulls, straw and weed seeds; also contains small amounts of ground corn, oats and rye.
6761	The Birkett Mills, Penn Yan, N. Y "Buckwheat Offal Feed'	Penn Yan	G 10.	2.25	32.	This feed contains buckwheat offal and buckwheat screenings consisting of buckwheat chaff and weed seeds not exceeding mill run.
			F 14.3	3.8	24.5	Mainly buckwheat hulls and middlings with some weed seeds.
7528	The Birkett Mills, Penn Yan, N. Y. "Buckwheat Offal Feed"	Penn Yan	G 12.50	2.75	32.	
			F 11.6	2.7	27.1	Mainly buckwheat hulls and buckwheat bran, with a small amount of buckwheat middlings.
6756	Fred C. Campbell, Alpine, N. Y "Buckwheat Feed"	Alpine	G 14.	4.	27.	Buckwheat hulls and buckwheat midds mixed.
			F 19.3	5.6	17.2	As certified.
6044	Chase-Hubbard Milling Co., Breesport, N. Y. "Buckwheat Feed"	Breesport	G ——	——	——	Buckwheat hulls and middlings.
			F 5.0	1.3	39.1	Buckwheat hulls.

6785	Chase-Hubbard Milling Co., Breesport, N. Y. "Offal Feed"	Breesport	G	5.	——	40.	Buckwheat middlings, ground buckwheat hulls, ground buckwheat screenings, ground buckwheat chaff, ground corn bran and corn meal offal.
			F	11.3	2.9	27.4	Buckwheat hulls, buckwheat middlings, buckwheat screenings, with some ground corn, corn offal and corn bran.
6786	Chase-Hibbard Milling Co., Breesport, N. Y. "Dark Buckwheat Middlings"	Breesport	G	——	——	——	
			F	12.1	2.9	32.6	Buckwheat hulls and buckwheat middlings.
6777	Byron A. Hayes, Wayland, N. Y. "Buckwheat Feed"	Wayland	G	——	——	——	Buckwheat hulls and buckwheat middlings, mixed.
			F	18.5	5.	17.8	As certified.
6782	Hodgman Milling Co., Painted Post, N. Y. "Buckwheat Middlings"	Painted Post	G	——	——	——	Buckwheat middlings and a portion of hulls that do not screen out in process of manufacture.
			F	24.2	6.7	6.3	Buckwheat middlings, buckwheat hulls.
6751	Arthur T. Kelsey, Mecklenburg, N. Y. "Buckwheat Feed with Hulls"	Mecklenburg	G	——	——	——	
			F	16.4	4.6	25.3	Buckwheat hulls and buckwheat middlings.
7807	The Larrowe Milling Co., Cohocton, N. Y. "Buckwheat Middlings"	Owego	G	12.	4.	——	
			F	12.3	3.1	23.5	Buckwheat hulls, buckwheat middlings, ground screenings.
6753	George B. Patterson, Burdette, N. Y. "Buckwheat Feed"	Burdette	G	13.	3.	25.	All parts of buckwheat excepting flour.
			F	19.2	5.8	18.4	Buckwheat hulls and buckwheat middlings.
6781	Savonna Milling Co., Savonna, N. Y. "Buckwheat Feed"	Savonna	G	——	——	——	Buckwheat hulls and mill flour sweepings (oats, corn, barley, meals, etc.)
			F	7.5	2.	27.6	Mainly buckwheat hulls with small amounts of buckwheat middlings and mill sweepings containing ground corn, oats and barley.

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* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	BUCKWHEAT PRODUCTS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
6764	Chas. W. Slayton, Naples, N. Y. "Buckwheat Middlings"	Naples	G* —	—	—	Buckwheat middlings with a few hulls which are not separated in bolting.
			F* 21.4	7.4	5.3	Buckwheat middlings and buckwheat hulls.
	CORN FEED MEAL:					
7428	Consolidated Milling Co., Buffalo, N. Y. "'B' Meal"	Byron	G —	—	—	Supposed to be composed of residue of corn after better portions are taken for a high grade of table meal.
			F 10.3	6.3	4.5	Corn feed meal.
7435	Globe Elevator Co., Buffalo, N. Y. "'B' Meal"	Brockport	G —	—	—	Said to be composed of residue of corn after better portions were taken out in making a high grade table meal.
			F 10.	3.7	1.5	Corn feed meal.
6810	A. H. Herrick & Son, Watertown, N. Y. "Corn Meal"	Watertown	G —	—	—	Corn meal from the manufacture of cracked corn.
			F 7.7	2.	1.3	Corn feed meal.
6145	The McLean Mills, McLean, N. Y. "Corn Meal"	McLean	G —	—	—	
			F 7.4	1.2	.9	Corn feed meal.
6231	A. Nowak & Son, Buffalo, N. Y. "Pure Fine Yellow Feed Corn Meal"	Buffalo	G —	—	—	
			F 10.0	5.5	2.4	Corn feed meal.
6232	A. Nowak & Son, Buffalo, N. Y. "Yellow Coarse B Meal"	Buffalo	G —	—	—	
			F 9.8	4.4	2.6	Corn feed meal.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	GROUND CORN AND OATS:		*Per ct.*	*Per ct.*	*Per ct.*	
6779	James Faucett, Bath, N. Y. " Corn and Oat Chop "	Bath	G* — F* 11.1	— 4.9	— 4.5	Corn and oats, mixed and ground. Ground corn and oats.
6625	Finch Pruyn & Co., Inc., Glens Falls, N. Y. " Corn and Oat Feed or Horse Feed "	Glens Falls	G — F 10.3	— 4.5	— 4.2	Corn and oats. Ground corn and oats.
6778	John P. Morsch & Son, Wayland, N. Y. " Corn and Oat Chop "	Wayland	G — F 11.1	— 4.2	— 6.1	Straight corn and oat chop. Ground corn and oats.
	GROUND GRAIN SCREENINGS, FLAX SCREENINGS:					
7492	The Consolidated Milling Corp., Buffalo, N. Y. " Fine Ground Screenings "	Varysburg	G — F 13.4	— 6.9	— 12.1	Wheat screenings consisting largely of ground wheat, weed seeds, straw and chaffy material, and a small amount of ground oats.
7471	Moseley & Motley Milling Co., Rochester, N. Y. " By-product Ground Wheat Screenings "	Attica	G 12.5 F 13.9	3.5 7.	18.5 10.8	Ground screenings, containing ground wheat, oats, barley, flax, and weed seeds.
7493	A. Nowak & Son, Buffalo, N. Y. " Wheat Screenings "	Varysburg	G — F 11.5	— 4.1	— 15.3	Wheat screenings, containing ground wheat, oats, barley, weed seeds and pieces of straw and stems.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*concluded*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	MISCELLANEOUS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
6801	Cape Vincent Seed Co., Cape Vincent, N. Y.	Cape Vincent	G* 19.21	1.72	21.56	Said to be made from whole peas (unfit for seed purposes) pea hulls.
	" H. U. Pea Meal "		F* 14.7	1.4	28.1	Pea meal.
6269	General Flour & Feed Co., Buffalo, N. Y. " Buffalo Meal "	Syracuse	G 7.	3.	7.	Corn and cob meal, the amount of cob used being the same as though ear corn was ground cob and all.
			F 8.8	4.3	4.4	Corn and cob meal.
5673	The Larrowe Milling Co., Detroit, Mich.	Stamford	G 8.	.50	20.	Composed only of residue of sugar beets dried after extraction of sugar.
	" Dried Beet Pulp, Steam Dried "		F 8.3	.9	18.	Dried beet pulp.
7705	Purity Oats Company,	Walden	G 6.73	2.71	32.65	
	Davenport, Ia. " Purity Reground Oat Hulls "		F 6.3	2.	25.9	Oat hulls containing small amounts of oat shorts and oat middlings.
6284	The Shredded Wheat Co.,	Syracuse	G 10.	1.50	2.	
	Niagara Falls, N. Y. " Shredded Wheat Waste for Poultry "		F 12.2	1.9	1.8	Shredded-wheat waste.
7490	United Cereal Mills, Ltd., Buffalo, N. Y.	Attica	G 8.60	4.10	1.60	Hominy grits (cooked), one per ct. salt, three per ct. sugar.
	" Cooked Corn Feed "		F 7.9	1.7	.8	Cereal by-product from corn containing starchy material and small amounts of the germ and bran, salt, sugar, grits from white corn.

* These letters indicate, respectively, Guaranteed and Found.

FEEDING STUFFS' DEFINITIONS.

Meal is the clean, sound, ground product of the entire grain, cereal or seed which it purports to represent: Provided, that the following meals, qualified by their descriptive names, are to be known as, viz: *Corn germ meal* is a product in the manufacture of starch, glucose and other corn products and is the germ layer from which a part of the corn oil has been extracted. *Linseed meal* is the ground residue after extraction of part of the oil from ground flaxseed.

Cottonseed meal is a product of the cotton seed only, composed principally of the kernel, with such portion of the hull as is necessary in the manufacture of oil, provided that nothing shall be recognized as cottonseed meal that does not conform to the foregoing definition, and that does not contain at least thirty-six (36) per ct. of protein. *Choice cottonseed meal* must be finely ground, not necessarily bolted, perfectly sound and sweet in odor, yellow, free from excess of lint and must contain at least forty-one (41) per ct. of protein. *Prime cottonseed meal* must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint, and must contain at least thirty-eight and six-tenths (38.6) per ct. of protein. *Good cottonseed meal* must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color and must contain at least thirty-six (36) per ct. of protein.

Cold pressed cottonseed is the product resulting from subjecting the whole undecorticated cottonseed to the cold pressure process for the extraction of oil, and includes the entire cottonseed less the oil extracted. When cold pressed cottonseed is ground it shall be designated as "Ground Cold Pressed Cotton Seed."

Cottonseed feed is a mixture of cottonseed meal and cottonseed hulls containing less than thirty-six (36) per ct. of protein.

Grits are the hard flinty portions of Indian corn without hulls and germ.

Hominy meal, hominy feed, or *hominy chop* is a mixture of the bran coating, the germ and a part of the starchy portion of the corn kernel obtained in the manufacture of hominy grits for human consumption.

Corn feed meal is the sifting obtained in the manufacture of cracked corn and table meal made from the whole grain.

Corn bran is the outer coating of the corn kernel.

Corn gluten feed is that portion of commercial shelled corn that remains after the separation of the larger part of the starch and the germ by the processes employed in the manufacture of corn starch and glucose. It may or may not contain corn solubles.

Corn gluten meal is that part of commercial shelled corn that remains after the separation of the larger part of the starch, the germ and the bran by the processes employed in the manufacture of cornstarch and glucose. It may or may not contain corn solubles.

Wheat bran is the coarse outer coatings of the wheat berry obtained in the usual commercial milling process from wheat that has been cleaned and scoured.

Wheat bran with mill run screenings is pure wheat bran plus the screenings which were separated from the wheat used in preparing said bran.

Wheat bran with screenings not exceeding mill run is either wheat bran with the whole mill run of screenings or wheat bran with a portion of the mill run of screenings, provided that such portion is not an inferior portion thereof.

Any mixture of *wheat bran with other materials* which corresponds with either of the two above definitions or wheat bran which includes other foreign matter in appreciable quantities is regarded as a compounded feed and must be licensed for sale in this state.

Shorts, or *standard middlings* are the fine particles of the outer and the inner bran separated from bran and white middlings.

Shipstuff, or *wheat mixed feed* is a mixture of the products other than the flour obtained from the milling of the wheat berry.

Wheat white middlings or *white middlings* is that part of the offal of wheat intermediate between shorts or standard middlings and red dog.

Red dog is a low grade wheat flour containing the finer particles of bran.

Oat groats are the kernels of the oat berry with the hulls removed.

Oat shorts are the covering of the oat grain lying immediately inside the hull, being a fuzzy material carrying with it considerable portions of the fine floury part of the groat obtained in the milling of rolled oats.

Oat middlings are the floury portion of the groat obtained in the milling of rolled oats.

Oat hulls are the outer chaffy coverings of the oat grain.

Oat clippings are the hairs, oat dust, ends of oats and light oats separated from the oat kernel by the clipping process.

Clipped oat by-product is obtained in the manufacture of clipped oats. It may contain light chaffy material broken from the ends of the hulls, empty hulls, light immature oats and dust. It must not contain an excessive amount of oat hulls.

Rice hulls are the outer chaffy coverings of the rice grain.

Rice bran is the cuticle beneath the hull.

Rice polish is the finely powdered material obtained in polishing the kernel.

Flax plant by-product is that portion of the flax plant remaining after the separation of the seed, the bast fiber and a portion of the shives, and consists of flax shives, flax pods, broken and immature flax seeds and the corticle tissue of the stem.

Buckwheat shorts, or *buckwheat middlings* is that portion of the buckwheat grain immediately inside the hull after separation from the flour. (Mixtures of buckwheat middlings and buckwheat hulls are often sold as buckwheat middlings or buckwheat shorts. Such materials are regarded as misnamed.)

Blood meal is ground dried blood.

Meat scrap and *meat meal* are the ground residues from animal tissue exclusive of hoof and bone. If they contain any considerable amount of bone, they must be designated *meat and bone scrap*, or *meat and bone meal*. If they bear a name descriptive of their kind, composition or origin, they must correspond thereto.

Cracklings are the residue after partially extracting the fats and oils from the animal tissue. If they bear a name descriptive of their kind, composition or origin, they must correspond thereto.

Digester tankage is the residue from animal tissue exclusive of hoof and horn, specially prepared for feeding purposes by tanking under live steam. drying under high heat, and suitable grinding. If it contains any considerable amount of bone, it must be designated *digester meat and bone tankage*.

Distillers' dried grains are the dried residue from cereals obtained in the manufacture of alcohol and distilled liquors. The product shall bear the designation indicating the cereals of which these grains are composed.

Brewers' dried grains are the properly dried residue from cereals obtained in the manufacture of beer.

Malt sprouts are the sprouts of the barley grain. If the sprouts are derived from any other malted cereal, the source must be designated.

Alfalfa meal is the entire alfalfa hay, ground, and does not contain an admixture of ground alfalfa straw or other foreign materials.

Chop is a ground or chop feed composed of one or more different cereals or by-products thereof. If it bears a name descriptive of the kind of cereals, it must be made exclusively of the entire grains of those cereals.

Screenings are the smaller imperfect grains, weed seeds and other foreign material separated in cleaning the grain.

REPORT OF ANALYSES OF SAMPLES OF COMMERCIAL FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915.*

There are presented in this bulletin the analyses of samples of fertilizers collected by the Commissioner of Agriculture during 1915, and transmitted by him for analysis to the Director of the New York Agricultural Experiment Station, in accordance with the provisions of Article 9 of the Agricultural Law. These analyses and the accompanying information are published by said Director in accordance with the provisions of Section 224 of said Law.

Since many requests have been received for such data, it has been deemed best to give figures showing the current values of fertilizer ingredients, with an illustration of the method of applying these figures in determining the approximate commercial valuation of the different brands.

TRADE-VALUES OF PLANT-FOOD ELEMENTS IN RAW MATERIALS AND CHEMICALS

The trade-values in the following schedule have been agreed upon by the Experiment Stations of Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Vermont, as a result of study of the prices actually prevailing in the large markets of these states.

These trade-values represent, as nearly as can be estimated, the average prices at which, during the six months preceding March, the respective ingredients, *in the form of unmixed raw materials*, could be bought at retail for cash in our large markets. These prices also correspond (except in case of available phosphoric acid) to the average wholesale prices for the six months preceding March, plus about 20 per ct., in casė of goods for which there are wholesale quotations.

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* A reprint of Bulletin No. 410, October, 1915.

TRADE-VALUES OF PLANT-FOOD ELEMENTS IN RAW MATERIALS AND CHEMICALS.

	1915. Cts. per pound.
Nitrogen in nitrates	15
" ammonium salts	15½
Nitrogen, organic, in fine-ground, dry fish, blood and meat	22
" " in cottonseed-meal and castor-pomace	20
" " in fine-ground bone and tankage	21
" " in coarse bone and tankage	17
" " in mixed fertilizers	19
Phosphoric acid, water-soluble	4
" " citrate-soluble (reverted)	3½
" " in fine-ground fish, bone and tankage	4
" " in coarse fish, bone, tankage and ashes	3½
" " in cottonseed-meal and castor-pomace	3½
" " in mixed fertilizers, insoluble in ammonium citrate or water.	2
" " in high-grade sulphate and mixtures free from muriates	9½
" " in muriate	8½
" " in cottonseed-meal and castor-pomace	9½

VALUATION AND COST OF FERTILIZERS.

The total cost (to the farmer) of a ton of commercial fertilizer may be regarded as consisting of the following elements: (1) Retail cash cost, in the market, of unmixed trade materials; (2) cost of mixing; (3) cost of transportation; (4) storage, commissions to agents and dealers, selling on long credit, bad debts, etc. While the *total cost* of a fertilizer is made up of several different elements, a *commercial valuation* includes only the first of the elements entering into the total cost, that is, the retail cash cost in the market of unmixed raw materials.

VALUATION AND AGRICULTURAL VALUE.

The *agricultural value* of a fertilizer depends upon its *crop-producing power*. A commercial valuation does not necessarily have any relation to crop-producing value on a given farm. For a particular soil and crop, a fertilizer of comparatively low commercial valuation may have a higher agricultural value; while, for another crop on the same soil, or the same crop on another soil, the reverse might be true.

RULE FOR CALCULATING APPROXIMATE COMMERCIAL VALUATION OF MIXED FERTILIZERS ON BASIS OF TRADE-VALUES FOR 1915.

Multiply the percentage of nitrogen by 3.8.
Multiply the percentage of available phosphoric acid by 0.8.
Multiply the percentage of insoluble phosphoric acid (total minus available) by 0.4.
Multiply the percentage of potash by 1.8.

The sum of these 4 products will be the commercial valuation in dollars per ton on the basis taken.

Illustration.— The table of analyses shows a certain fertilizer to have the following composition: Nitrogen 2.52 per ct.; available phosphoric acid 6.31 per ct.; insoluble phosphoric acid .89 per ct.; potash 6.64 per ct. According to this method of valuation, the computation would be as follows:

Nitrogen	2.52 x 3.8	$9.58
Available phosphoric acid	6.31 x 0.8	5.05
Insoluble phosphoric acid	0.89 x 0.4	0.36
Potash	6.64 x 1.8	11.95
		$26.94

Farmers should be warned against judging fertilizers by their valuations. A fertilizer, the cost of which comes chiefly from the phosphoric acid present, would value much lower commercially than a fertilizer with a high percentage of nitrogen, and yet the former might be the more profitable one for a given farmer to purchase.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915.

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
Alphano Humus Co., New York, N. Y.						
Alphano Prepared Humus		G*	1.25	0.50	——	0.50
Babylon	6067	F*	1.47	0.74	1.32	0.42
American Agricultural Chemical Co., New York, N. Y.						
Acme Early Crop Producer Special		G	4.11	10	11	4
Greenlawn	0675	F	3.89	10.01	10.85	4.52
Acme Special No. 1 Potato Manure		G	3.29	8	9	4
New York	0663	F	3.24	8.57	9.99	4.12
Basic Lime Phosphate		G	——	13	14	——
Calverton	6074	F	——	13.25	14.71	——
Bone Meal		G	1.63	——	13.73	——
New York	0353	F	2.07	——	18.75	——
Bradley's Alkaline Phosphate and Potash		G	——	10	11	2
Penn Yan	6594	F	——	11.01	12.41	2.18
Bradley's B. D. Guano		G	0.82	8	9	3
Florida	0515	F	0.92	8.13	9.57	2.83
Bradley's Big Dipper		G	2.47	8	9	2
Sherburne	6937	F	2.26	8.07	10.95	2.16
Bradley's Complete Manure for Potatoes and Vegetables Special		G	3.29	8	9	4
Aquebogue	0572	F	3.22	7.97	9.61	4.10
Bradley's Eclipse Phosphate		G	1.03	8	9	2
Penn Yan	6593	F	1.19	8.36	9.56	2.44
Bradley's Golden Eagle Special		G	4.11	8	9	3
North Collins	0924	F	4.02	8.18	10.14	3.08
Bradley's Half Century Fertilizer		G	2.06	8	9	3
Locke	6561	F	1.98	8.14	9.84	3.12

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* These letters indicate, respectively, Guaranteed and Found.

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
Bradley's King George		G*	1.23	8	9	2.50
Moscow	6679	F*	1.25	7.96	9.04	2.26
Bradley's New Method Fertilizer		G	0.82	8	9	2
Florida	0505	F	0.92	8.81	10.25	2.14
Bradley's New Rival Fertilizer Special		G	1.23	9	10	2
Merrifield	0412	F	1.35	9.50	11.20	2.26
Bradley's Niagara Phosphate		G	0.82	7	8	1
Yonkers	4832	F	0.84	7.64	9.40	0.95
Bradley's Patent Super Phosphate		G	2.06	8	9	1.50
Locke	6559	F	1.87	8.38	10.25	1.64
Bradley's Special B. D. Guano		G	0.82	8	9	3
Bergen	6476	F	0.96	8.32	9.56	3
Bradley's Special B. D. Guano		G	0.82	8	9	3
Locke	6560	F	0.92	8.20	9.86	2.93
Bradley's Special Magic Phosphate		G	——	12	13	2
Franklinville	5995	F	——	11.88	12.42	2
Bradley's Special Superior Compound		G	0.82	9	10	2
Stittville	6762	F	1.11	9.04	10.88	1.96
Bradley's Unicorn		G	1.65	8	9	2
Locke	6562	F	1.82	8.52	10.15	2.10
Bradley's Vegetable Fertilizer		G	3.29	10	11	3
Groton	6195	F	3.32	10.09	11	3.08
Clark's Cove King Philip Alkaline Guano		G	1.03	8	9	2
Orchard Park	0299	F	0.78	7.34	8.79	1.88
Crocker's Ammoniated Superphosphate		G	2.47	9	10	2
Dundee	0124	F	2.36	8.92	11	2.16

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
Crocker's Anchor Brand Special		G*	1.65	10	11	3
Lodi	0138	F*	1.67	11.42	12.80	2.56
Crocker's Best Truck Manure		G	4.11	8	9	3
Sinclairville	0916	F	3.84	8.90	10.90	3.04
Crocker's Dissolved Phosphate and Potash		G	——	10	11	2
Cherry Valley	0307	F	——	10.14	11.56	2.10
Crocker's Garden Fertilizer		G	3.29	9	10	2
North Tonawanda	0218	F	3.11	9.27	10.95	2.16
Crocker's General Crop Fertilizer		G	0.82	7	8	1
Cherry Valley	0309	F	1.00	8.47	9.71	1.39
Crocker's Harvest Jewel Fertilizer		G	1.65	8	9	2
Center Village	0396	F	1.86	8.08	9.40	2.96
Crocker's High Grade Special Revised		G	1.65	8	9	3
Cherry Valley	0305	F	1.60	8.46	9.60	3.22
Crocker's New Rival Fertilizer		G	1.23	9	10	2
Dundee	0123	F	1.42	9.24	10.80	2.30
Crocker's Nobsque Guano		G	1.03	8	9	2
Ontario	0605	F	0.85	7.40	8.80	2.09
Crocker's Paragon Phosphate Special		G	——	12	13	2
Palmyra	0623	F	——	11.67	12.35	2.10
Crocker's Potato, Hop and Tobacco Fertilizer		G	2.06	8	9	3
Gowanda	0282	F	2.03	7.99	9.85	3.04
Crocker's Special Colonial Fertilizer	0217	G	2.47	10	11	3
Sandusky		F	2.53	10.10	11.48	3.04
Crocker's Special Complete Manure		G	0.82	8	9	3
Newark	6572	F	0.88	7.36	8.36	2.85

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
Crocker's Special Potato Manure Revised		G*	3.29	8	9	4
Cutchogue	6059	F*	3.24	8.07	9.65	4.26
Crocker's Universal Grain Grower		G	0.82	8	9	2
Tonawanda	0219	F	0.86	7.96	9.60	2.16
Crocker's Wheat and Corn Fertilizer		G	2.06	8	9	1.50
Cherry Valley	0306	F	2.23	8.10	10.10	1.60
Darling's Blood, Bone and Potash Special		G	4.11	10	11	4
Jamesport	6052	F	4.09	10.46	11.22	3.90
Darling's Special Long Island A		G	3.29	8	9	4
Mattituck	0565	F	3.31	7.86	9.12	4.12
Dry Ground Fish		G	8.23	——	6	——
New York	0669	F	8.54	——	7.67	——
East India Corn King Special		G	2.47	10	11	3
Deposit	6933	F	2.23	9.87	11.07	2.70
East India Economizer Phosphate		G	0.82	8	9	2
Deposit	6931	F	1.41	7.94	9.08	4.15
East India Garden and Farm Special Manure		G	3.29	10	11	3
Deposit	6932	F	3.28	9.88	11.12	3
East India Ideal Mixture		G	——	10	11	2
Apalachin	5887	F	——	10.34	11.64	2.30
East India Ideal Mixture		G	——	10	11	2
Cortland	04	F	——	9.88	10.44	2.06
East India Mayflower		G	1.65	8	9	2
Cortland	07	F	1.77	7.96	9.46	2.08
East India Monarch Phosphate Special		G	——	12	13	2
Mapleton	0411	F	——	12.11	12.91	2.26

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
East India Pilgrim Fertilizer Special		G*	0.82	8	9	3
Cortland	05	F*	0.95	8.06	9.86	3
East India Revised Victor Special		G	3.29	8	9	4
Bridgehampton	0588	F	3.37	8	8.90	4.73
East India Roanoke Phosphate		G	1.03	8	9	2
Sherburne	6936	F	1.23	8.22	9.60	1.87
East India Unexcelled Fertilizer		G	2.06	8	9	3
White Plains	4836	F	2.29	8.35	9.35	2.96
East India Unexcelled Fertilizer		G	2.06	8	9	3
New York	0668	F	2.07	8.43	9.59	3.32
Fine Ground Bone		G	2.47	——	22.88	——
New York	0352	F	2.61	——	26.49	——
14% Acid Phosphate		G	——	14	15	——
Franklinville	5994	F	——	13.07	14.21	——
Great Eastern Dissolved Acid Phosphate		G	——	14	15	——
Salem	4893	F	——	13.80	14.36	——
Great Eastern Garden Special Revised		G	3.29	8	9	4
Water Mill	0589	F	3.25	7.86	9.10	4.27
Great Eastern General Revised		G	0.82	8	9	2
Jordanville	6705	F	0.86	9.95	10.15	2.06
Great Eastern General Revised		G	0.82	8	9	2
Florida	0518	F	1.05	8.12	9.98	2.22
Great Eastern High Grade Potato Fertilizer		G	1.65	10	11	3
Gouverneur	5263	F	1.60	10.07	11.37	3.22
Great Eastern Peerless Potato Special Manure		G	1.23	10	11	2.50
Clayton	5266	F	1.18	10.01	11.43	2.70

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* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
American Agricultural Chemical Co., New York, N. Y. (*continued*)						
Great Eastern Soluble Bone and Potash		G*	——	11	12	2
East Schodack	0875	F*	——	10.80	12.20	2.12
Great Eastern Vegetable Vine and Tobacco		G	2.06	8	9	3
Florida	0506	F	2.08	8.27	10.11	3.16
Ground Tankage 6-30		G	4.94	——	13.73	——
New York	0400	F	4.89	——	14.76	——
High Grade Crop Producer		G	1.65	9	10	3
Groton	6196	F	1.83	9.17	10.26	3.16
High Grade Dried Blood		G	9.87	——	——	——
New York	0386	F	9.55	——	——	——
Lazaretto Complete Truck Fertilizer		G	3.29	10	11	3
Canandaigua	6668	F	3.00	10.73	12.03	3.02
Michigan Carbon Works General Crop Fertilizer Special		G	0.82	8	9	3
Fredonia	0249	F	0.81	7.93	8.99	3.14
Michigan Carbon Works Homestead Fertilizer		G	2.06	8	9	1.50
Newark	6570	F	2.01	7.84	9.18	1.70
Michigan Carbon Works Homestead Potato and Tobacco Fertilizer		G	2.06	8	9	3
Newark	6571	F	2.05	7.92	9.50	3.04
Michigan Carbon Works Red Line Phosphate with Potash		G	——	10	11	2
Fredonia	0248	F	——	9.77	10.45	1.90
Milsom's Buffalo Fertilizer		G	2.06	8	9	1.50
West Falls	0923	F	2.07	8.22	9.48	1.86
Milsom's Buffalo Guano Special		G	0.82	8	9	3
Elba	6490	F	0.83	7.90	8.96	3.12

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
Milsom's Buffalo Guano Special		G*	0.83	8	9	3
Hudson	0486	F*	0.83	8.47	9.55	3.02
Milsom's Corn Fertilizer		G	2.47	9	10	2
Lyons	6576	F	2.46	8.36	9.82	1.98
Milsom's Crown Phosphate		G	——	10	11	2
Dundee	0122	F	——	10.84	12.40	2.14
Milsom's Erie King Fertilizer		G	0.82	7	8	1
Lestershire	6946	F	0.88	8.08	9.80	1.16
Milsom's Erie King Fertilizer		G	0.82	7	8	1
Romulus	0127	F	0.86	7.10	8.54	0.99
Milsom's Good Progress		G	2.47	5	6	3
Clarence	0297	F	2.19	4.96	6.24	3.35
Milsom's Imperial Phosphate Special		G	——	12	13	2
Penn Yan	0116	F	——	12.39	12.73	2.04
Milsom's Potato, Hop and Tobacco Fertilizer		G	2.06	8	9	3
McGrawville	03	F	2.00	8.02	10.10	3
Milsom's Special Potato and Cabbage Manure		G	0.82	9	10	3
Andover	0215	F	0.84	9.10	10.26	3.25
Milsom's Special Soil Enricher		G	1.65	8	9	3
Lyons	6573	F	1.68	7.70	9.32	3.53
Milsom's Truck Fertilizer		G	3.29	10	11	3
Lyons	6574	F	3.09	10.43	11.99	3.12
Milsom's Wheat, Oats and Barley Fertilizer		G	0.82	8	9	2
Lyons	6575	F	0.86	7.23	8.65	2.20
Nitrate of Soda		G	15	——	——	——
Mattituck	0566	F	14.85	——	——	——

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid Available	Phosphoric acid Total	Potash
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
North Western Challenge Fertilizer		G*	1.03	8	9	2
Lowville	6706	F*	1.04	10.01	10.29	2.08
North Western Complete Compound Special		G	0.82	8	9	3
Oneonta	6778	F	1.08	8.49	10.01	3.18
North Western Electric Phosphate		G	——	10	11	2
Watkins	6589	F	——	10.23	10.95	2
North Western Horse Shoe Brand Special		G	——	12	13	2
Lestershire	6909	F	——	12.31	13.23	2.80
North Western Red Line Fertilizer Special		G	2.47	8	9	3
Lestershire	6908	F	2.26	8.50	9.98	3.97
North Western Special Diamond Potash Mixture		G	1.65	10	11	3
Oneonta	6777	F	1.61	10.39	11.81	2.86
North Western Special Garden Manure		G	3.29	10	11	3
Oneonta	6770	F	1.89	8.58	10.15	2.79
North Western Special Shawnee Phosphate		G	1.65	8	9	3
Florida	0503	F	1.68	8.29	10.03	2.98
North Western Success Phosphate		G	0.82	7	8	1
Heddens	6991	F	0.99	7.76	8.30	1.24
Odorless Grass and Lawn Top Dressing		G	3.91	5	6	2
Albany	0711	F	3.75	5.20	5.70	2.02
Pacific Nobsque General Guano		G	1.03	8	9	2
Colden	0921	F	0.91	8.21	9.45	2.06

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
Packers' Union Banner Wheat Grower		G*	——	10	11	2
East Schodack	0873	F*	——	11.18	12.66	2.20
Packers' Union Old Abe Superior Crop Grower		G	0.82	8	9	3
Florida	0537	F	0.98	8.52	9.82	2.92
Packers' Union Special Potato Manure		G	2.06	8	9	3
New York	0660	F	2.16	8.46	9.70	3.48
Packers' Union Superior Acid Phosphate		G	——	14	15	——
Bainbridge	068	F	——	14.21	16.35	——
Potomac Garden and Corn Manure		G	2.47	10	11	3
New York	0390	F	2.49	10.16	11.54	3.12
Potomac General Crop Compound		G	2.47	8	9	3
New York	0384	F	2.50	7.75	9.35	2.96
Potomac Ideal Potato Manure		G	3.29	10	11	3
New York	0385	F	3.28	10.22	11.22	2.96
Potomac Special Truck Manure		G	4.11	8	9	3
New York	0383	F	4.21	8.21	9.45	3.92
Pulverized Sheep Manure		G	2.06	——	1.25	1
New York	0670	F	2.05	1.67	1.79	6.19
Pure Unleached Canada Hardwood Ashes		G	——	——	——	2
Northport	6100	F	——	——	——	2.61
Quinnipiac Ammoniated Dissolved Bone		G	1.65	8	9	2
Springwater	0435	F	1.65	8.34	9.10	2
Quinnipiac "B" Fertilizer Special		G	0.82	8	9	3
Colden	0922	F	0.82	7.85	8.91	3.06

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
Quinnipiac Climax Phosphate		G*	1.03	8	9	2
Romulus	0126	F*	0.88	8.27	9.97	2.42
Quinnipiac Market Garden Manure Special		G	3.29	8	9	4
Hicksville	0684	F	3.32	8.80	9.90	4.52
Quinnipiac Mohawk Fertilizer		G	0.82	7	8	1
Baldwinsville	033	F	0.90	7.78	9.66	0.96
Quinnipiac Potato Phosphate		G	2.06	8	9	3
Orchard Park	0300	F	2.04	8.43	10.11	3.28
Raw Calcutta Bone		G	3.70	—	22.88	—
Newburgh	5609	F	3.87	—	22.79	—
Read's All Crops Fertilizer		G	0.82	9	10	3
Florida	0504	F	1.07	9.50	10.70	3.12
Read's Champion Phosphate		G	—	10	11	2
Pleasantville	0466	F	—	10.93	12.45	2.10
Read's Farmers' Friend Superphosphate		G	2.06	8	9	3
Clyde	0103	F	2.06	8.12	10.20	3.16
Read's Farmers' Reliable Special		G	—	12	13	2
Manlius	022	F	—	12.62	13.96	2
Read's High Grade Farmer's Friend Superphosphate Special		G	3.29	10	11	3
East Homer	017	F	2.25	8.85	10.08	2.75
Read's Leader Fertilizer		G	0.82	7	8	1
Pleasantville	0467	F	1.11	8.09	9.45	1.24
Read's Lightning Brand		G	4.94	7	8	3
Clarence Center	0298	F	3.74	7.24	8.66	2.64
Read's Pioneer Fertilizer		G	0.82	8	9	2
East Homer	016	F	0.93	8.67	9.63	2.10

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
Read's Potato and Truck Phosphate		G*	3.29	8	9	4
Wyandanch	6092	F*	3.54	8.11	9.39	4.39
Read's Special Corn, Wheat and Rye Fertilizer		G	1.65	8	9	3
Bergen	6475	F	1.66	7.90	9.44	3.28
Read's Vegetable and Vine Fertilizer Special		G	2.47	8	9	3
Lowville	6707	F	2.59	9.02	9.84	3.95
Reese's Crown Phosphate and Potash		G	——	11	12	2
East Bethany	6655	F	——	12.67	13.55	1.89
16% Acid Phosphate		G	——	16	17	——
Watkins	6588	F	——	16.60	17.38	——
Special Complete Manure for Top Dressing		G	4.94	7	8	3
New York	0662	F	4.98	7.23	8.65	3.14
Wheeler's Corn Fertilizer		G	1.65	8	9	2
New York	0671	F	1.78	8.66	10.62	2.27
Wheeler's Grass and Oats		G	——	11	12	2
Hartwick	6792	F	——	11.44	12.68	2.18
Wheeler's Peerless Acid Phosphate		G	——	14	15	——
Erin	0427	F	——	14.68	15.46	——
Wheeler's Potato Manure		G	2.06	8	9	3
New York	0659	F	2.15	8.69	9.89	3.44
Wheeler's Royal Wheat Grower		G	0.82	8	9	2
Pine Island	0519	F	0.93	8.04	9.18	2.28
Wheeler's Special Superior Truck		G	3.29	8	9	4
New York	0664	F	3.37	8.54	10	4.31
Wheeler's Truck Fertilizer		G	3.29	6	7	3
Mahopac	0464	F	3.37	8.24	10.04	2.63

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid Available	Phosphoric acid Total	Potash
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
Williams & Clark's Americus Corn Phosphate		G*	2.06	8	9	1
East Schodack	0877	F*	2.06	7.79	9.83	1.22
Williams & Clark's Americus Potato Manure		G	2.06	8	9	3
Chateaugay	3792	F	2.06	8.91	10.75	3.18
Williams & Clark's Elk Brand Special		G	0.82	8	9	3
Berlin	4866	F	1.01	8.78	10.44	3.10
Williams & Clark's Fruit Tree Invigorator		G	——	10	11	8
Apalachin	5888	F	——	10.68	11.64	8.08
Williams & Clark's Matchless Fertilizer		G	1.65	8	9	2
Hamburg	0273	F	1.59	8.50	9.90	2.06
Williams & Clark's Meadow Queen Fertilizer		G	2.47	9	10	2
White Plains	0474	F	2.65	10.01	11.25	2.33
Williams & Clark's Potato Phosphate Special		G	2.47	8	9	3
Hamburg	0275	F	2.34	8.50	10	3.14
Williams & Clark's Prolific Fertilizer		G	0.82	7	8	1
Hamburg	0274	F	0.89	7.87	9.15	1.02
Williams & Clark's Royal Phosphate		G	1.03	8	9	2
Harpersville	6969	F	1.18	9.12	10.22	2.14
Williams & Clark's Triumph Phosphate		G	——	10	11	2
Berlin	4864	F	——	10.66	11.60	2.08
Williams & Clark's Utility Brand		G	3.29	10	11	3
Williamson	6496	F	3.11	10.20	11.70	3.44
XXX Phosphate & Potash Special		G	——	14	15	2
Deposit	6935	F	——	14.21	15.53	2.22

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*concluded*)						
Zell's Economizer Phosphate		G*	0.82	8	9	2
Stafford	0635	F*	0.98	8.29	9.29	2.02
Zell's Electric Phosphate		G	——	10	11	2
Waterloo	6579	F	——	10.13	10.75	2
Zell's High Grade Phosphate and Potash		G	——	12	13	2
Marion	0621	F	——	12.07	12.69	1.91
Zell's High Grade Wheat and Corn Manure Special		G	1.65	10	11	3
Marion	0620	F	1.74	9.82	11.62	3.28
Zell's Hustler Phosphate		G	0.82	9	10	3
Waterloo	6577	F	0.89	8.76	9.96	2.88
Zell's Revised Special Compound for Potatoes and Vegetables		G	2.47	8	9	3
Waterloo	6578	F	2.47	8.40	9.90	2.67
Zell's Victor Manure		G	3.29	6	7	3
Prattsburg	0404	F	3.11	6.76	8.44	3
AMERICAN FERTILIZING CO., BALTIMORE, MD.						
American Eagle Crop Grower		G	1.65	8	9	2
Manlius	024	F	1.89	8.66	9.25	2
American Eagle Crop Grower		G	1.65	8	9	2
Medina	0294	F	1.91	8.10	8.72	2.34
American Eagle Truck and Vegetable Manure		G	3.29	8	9	3
Manlius	026	F	2.85	9.25	10.10	3.19
American Eagle Truck and Vegetable Manure		G	3.29	8	9	3
Medina	0295	F	3.18	8.86	9.72	3.25
American Fish and Bone Compound		G	1.65	8	9	3
Trumansburg	08	F	1.62	8.08	9.80	3.30

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
American Good Luck Crop Compound		G*	1.65	12	13	3
Rushville	0145	F*	2.01	12.94	13.84	3.71
American Grain and Grass Grower		G	0.82	9	10	3
Attica	0644	F	0.91	9.29	10.65	3.52
American High Grade Acid Phosphate		G	——	16	17	——
South Dayton	0288	F	——	17.68	18.18	——
American Pilot Grain Grower		G	0.82	12	13	1
Rushville	0144	F	1.09	13.06	13.74	1.28
American Premium Phosphate and Potash		G	——	12	13	2
Manlius	025	F	——	12.66	14.04	2.16
American Rescue Crop Compound		G	1.65	10	11	3
Springville	0260	F	1.70	11.41	12.65	3.18
American Victor Phosphate and Potash		G	——	14	15	2
Batavia	0637	F	——	14.60	15.82	2.45
Ammoniated Bone Compound		G	0.82	8	9	2
South Dayton	0289	F	0.96	8.32	9.44	2.22
Bob White Emergency Compound		G	1.23	9	10	3
Springville	0259	F	1.25	9.25	10.35	3.43
Dissolved Bone and Potash		G	——	10	11	2
Trumansburg	013	F	——	11.98	13.50	1.77
High Grade Acid Phosphate		G	——	14	15	——
Eagle	6671	F	——	16.12	16.60	——
Pure Raw Bone		G	2.87	——	16	——
South Dayton	0286	F	2.50	——	13.16	——
10% Tankage		G	8.23	——	——	——
South Dayton	0287	F	8.28	——	——	——

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* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
Armour Fertilizer Works, Baltimore, Md.						
Armour's 2-12-2 Fertilizer		G*	1.65	12	12.50	2
Wyoming	6663	F*	1.56	13.25	13.49	1.98
Armour's 3-8-3 Fertilizer		G	2.47	8	8.50	3
Homer	6199	F	2.52	7.87	8.97	3.16
Armour's 3-8-3 Fertilizer		G	2.47	8	8.50	3
Earlville	6950	F	2.45	8.65	9.41	3.06
Armour's 3-8-3 Fertilizer		G	2.47	8	8.50	3
Syracuse	035	F	2.41	7.89	8.33	3.04
Armour's 4-8-3 Fertilizer		G	3.29	8	8.50	3
Boonville	6760	F	3.25	7.34	9.22	3.30
Armour's 4-8-4 Fertilizer		G	3.29	8	8.50	4
Riverhead	0595	F	3.55	7.64	9.07	3.94
Armour's 5-8-3 Fertilizer		G	4.11	8	8.50	3
Florida	0512	F	4.10	7.42	9.12	3.02
Armour's 5-8-4 Fertilizer		G	4.11	8	8.50	4
Riverhead	0596	F	3.94	7.69	9.23	4.26
Armour's 5½-4-3 Fertilizer		G	4.52	4	4.50	3
Corning	0430	F	4.67	3.94	4.80	3.24
Armour's 6-9-3 Fertilizer		G	4.93	9	9.50	3
Amity	0522	F	4.21	8.33	9.52	3.62
Armour's Acid Phosphate		G	——	16	16.50	——
Rome	6702	F	——	16.40	17.10	——
Armour's Bone Meal		G	2.47	——	22	——
Springville	5986	F	2.82	——	23.78	——
Armour's Corn and Grain Champion		G	1.65	9	9.50	3
Springville	5988	F	1.66	8.91	9.81	3
Armour's Crop Grower		G	0.82	8	8.50	2
Boonville	6756	F	0.89	8.10	8.98	1.88

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
ARMOUR FERTILIZER WORKS, BALTIMORE, MD. (*concluded*)						
Armour's Farmers Choice		G*	0.82	9	9.50	3
Boonville	6757	F*	0.82	8.90	9.47	3.01
Armour's Grain Grower		G	1.65	8	8.50	2
Springville	5987	F	1.49	8.37	9.05	2.16
Armour's Ground Tankage 9 and 11		G	7.40	——	6.87	——
Rome	6703	F	7.30	——	6.75	——
Armour's Phosphate and Potash		G	——	12	12.50	2
Boonville	6755	F	——	12.17	12.65	1.90
Armour's Phosphate and Potash No. 1		G	——	10	10.50	2
Boonville	6759	F	——	9.95	10.29	2.16
Armour's Raw Bone Meal		G	3.70	——	21.50	——
Springville	0253	F	3.43	——	21.90	——
Armour's Star Phosphate		G	——	14	14.50	——
Yorktown	0480	F	——	13.98	14.32	——
Armour's Star Phosphate		G	——	14	14.50	——
Aquebogue	0571	F	——	14.01	14.19	——
Armour's Wheat, Corn and Oat Special		G	0.82	7	7.50	1
Boonville	6761	F	0.94	6.77	7.69	1.26
Dried Blood		G	13.16	——	——	——
Creedmore	6098	F	13.17	——	——	——
Nitrate of Soda		G	14.81	——	——	——
Middletown	0510	F	15.29	——	——	——
Nitrate of Soda		G	14.81	——	——	——
Kings Park	0804	F	15.38	——	——	——
ATLANTIC FERTILIZER WORKS, BALTIMORE, MD.						
Atlantic Arrow Brand Special		G	0.82	8	——	1
Sidney	6444	F	0.81	8.66	10.52	0.86

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
ATLANTIC FERTILIZER WORKS, BALTIMORE, MD. (*concluded*)						
Atlantic Blood, Bone, Fish and Potash		G[*]	2.47	8	——	3
Bridgewater	6799	F[*]	2.15	7.21	8.38	2.74
Atlantic Corn, Wheat and Oats Special		G	0.82	11	——	3
Greene	6980	F	0.80	11.12	12.77	2.68
Atlantic Dissolved Phosphate		G	——	16	——	——
Sidney	6447	F	——	17.55	19.05	——
Atlantic G. G. G. Golden Grain Grower		G	1.65	9	——	1
Sidney	6443	F	1.50	10.94	11.54	1.86
Atlantic Gold Medal Superior for All Crops		G	1.65	8	——	3
Greene	6981	F	1.46	9.41	10.75	2.56
Atlantic Jumbo Crop Grower		G	0.82	12	——	1
Bridgewater	6800	F	0.84	12.10	13.46	0.92
Atlantic Standard Compound		G	1.65	8	——	2
Bridgewater	6701	F	1.50	8.76	9.62	2.12
ATLANTIC PACKING CO., SYRACUSE, N. Y.						
Atlantic Animal Brand, A Complete Fertilizer for All Crops		G	2.46	8	9	3
Orchard Park	0901	F	2.35	8.71	8.85	3.08
Atlantic Corn and Wheat Brand		G	1.64	8	9	2
Orchard Park	0903	F	1.49	7.89	9.17	2.04
Atlantic Garden and Truck Manure		G	3.28	8	9	3
Orchard Park	0902	F	3.05	6.77	9.50	3.21
Atlantic Grass and Grain Brand for Oats, Buckwheat and Seeding Down		G	0.82	7	8	2
Deerfield	6714	F	0.86	7.29	8.31	1.99

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[*] These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
ATLANTIC PACKING CO., SYRACUSE, N. Y. (*concluded*)						
Atlantic Ground Bone		G*	2.45	——	23	——
Oneida	6940	F*	3.53	——	23.37	——
Atlantic Hop and Potato Brand		G	0.82	8	9	3
Deerfield	6713	F	0.87	8.57	9.25	3
Atlantic Reliable Brand		G	1.24	8	9	3
Oneida	6939	F	1.36	7.70	9.37	2.96
Atlantic 12-2 Brand		G	——	12	13	2
Oneida	055	F	——	12.33	12.55	1.94
Atlantic Vegetable Brand for Celery, Cabbages and Potatoes		G	2.05	8	9	3
Randallsville	052	F	2.22	8.14	9.04	3.20
BAUGH & SONS CO., BALTIMORE, MD.						
Baugh's Animal Base and Potash Compound for All Crops		G	1.65	8	——	2
Walton	6424	F	1.68	9.30	10.30	2.16
Baugh's Animal Base and Potash Compound for all Crops		G	1.65	8	——	2
Clifton Springs	6582	F	1.70	8.06	9.72	2.07
Baugh's Balanced Plant Food, A Superior Fertilizer for General Use		G	1.65	10	——	2
St. Johnsville	4969	F	1.73	10.99	12.44	2.44
Baugh's Combination Animal Base Fertilizer		G	1.65	10	——	3
Clifton Springs	6581	F	1.76	9.88	11.16	3.43
Baugh's Commercial Super-Phosphate for General Use		G	1.65	10	——	2
Central Bridge	0321	F	1.79	11.44	12.65	2.53
Baugh's Complete Animal Base Fertilizer		G	1.65	10	——	2
Binghamton	5891	F	1.98	9.84	11.76	2.18

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
Baugh & Sons Co., Baltimore, Md. (*continued*)						
Baugh's Double Eagle Twenty-Five Dollar Phosphate		G*	1.65	8.50	——	1
Hammondsport	0408	F*	1.66	8.86	10.70	1.26
Baugh's Excelsior Guano Revised		G	1.02	10	——	3
Lodi	0136	F	1.10	10.04	11.38	3.10
Baugh's Fine Ground Bone		G	2.47	——	16.49	——
Binghamton	5893	F	2.88	——	20.75	——
Baugh's General Crop Grower for All Crops		G	0.82	8	——	1
Binghamton	5890	F	1.01	8.77	9.83	1.43
Baugh's General Crop Grower for All Crops		G	0.82	8	——	1
Walton	6420	F	1.02	8.40	9.40	1.22
Baugh's Grand Rapids High Grade Guano		G	2.47	8	——	3
Berkshire	6197	F	2.61	8.60	9.71	3
Baugh's High Grade Acid Phosphate		G	——	14	——	——
St. Johnsville	4972	F	——	14.62	14.72	——
Baugh's High Grade Acid Phosphate		G	——	14	——	——
Walton	6422	F	——	14.69	15.01	——
Baugh's High Grade Ammoniated Animal Base		G	3.30	10	——	——
Spencer	6960	F	3.25	11.88	13.02	——
Baugh's High Grade Potato Grower		G	3.3	8	——	3
St. Johnsville	4971	F	3.41	9	10.86	3.31
Baugh's High Grade Potato Grower		G	3.30	8	——	3
Walton	6423	F	3.27	8.73	10.55	3.22
Baugh's High Grade Potash Mixture		G	——	13	——	2
Conklin Center	6955	F	——	13.97	14.65	1.74

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
BAUGH & SONS CO., BALTIMORE, MD. (*concluded*)						
Baugh's Peninsula Grain Producer		G*	0.82	9	——	3
Berkshire	6198	F*	1.00	9.33	10.29	2.97
Baugh's Potato and Truck Special for All Truck Crops Revised		G	2.88	10	——	3
Seneca Falls	0142	F	2.69	10.46	11.28	3.12
Baugh's Pure Bone and Potash Mixture		G	2.47	——	15	3
Cooperstown	6776	F	2.54	——	15.25	3.24
Baugh's Pure Steamed Bone		G	1.65	——	25	——
Williamson	0603	F	1.84	——	25.37	——
Baugh's Raw Bone Meal		G	3.7	——	21.50	——
Cooperstown	6775	F	4.15	——	21.60	——
Baugh's 16% Acid Phosphate		G	——	16	——	——
Binghamton	5892	F	——	16.08	16.20	——
Baugh's Soluble Alkaline Superphosphate		G	——	10	——	2
Hammondsport	0409	F	——	10.22	11.36	2.02
Baugh's The Old Stand-by Dissolved Animal Base		G	1.65	12	——	——
Central Bridge	0322	F	1.85	12.81	13.15	——
Fine Ground Blood		G	9.68	——	——	——
Yorktown	0481	F	10.35	——	——	——
Fine Ground Blood		G	9.87	——	——	——
Kings Park	0803	F	10.10	——	——	——
High Grade Tankage		G	7.40	——	4	——
Oneida	6942	F	7.21	——	9	——
Nitrate of Soda		G	15.23	——	——	——
Oneida	6941	F	15.30	——	——	——
Special Potato Manure		G	1.65	10	——	3
St. Johnsville	4970	F	1.83	10.60	11.82	3.36

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
THE BERG CO., PHILADELPHIA, PA.						
Berg's High Grade Potato Manure		G*	3	8	11	4
Ossining	4841	F*	3.05	7.98	9.92	3.98
Berg's Lucky Five		G	4.11	8	11	2
Ossining	4839	F	3.80	7.88	9.36	2.10
Berg's Raw Bone Fine		G	3	——	22	——
Ossining	4842	F	3.35	——	20.10	——
Berg's Raw Bone Fine		G	3	——	22	——
New York	0552	F	3.08	——	21.93	——
Berg's Standard Bone Manure		G	3	8	11	2.50
Ossining	4840	F	2.50	8.16	9.92	2.32
BERKSHIRE FERTILIZER CO., BRIDGEPORT, CONN.						
Berkshire Ammoniated Bone Phosphate		G	0.8	8	9	2
Arlington	0451	F	1.10	8.56	9.04	2.07
Berkshire Complete Fertiliser		G	2.5	8	9	3
Arlington	4848	F	2.57	7.96	8.76	3.46
Berkshire Economical Grass Fertilizer		G	8	4	8	2
Arlington	4850	F	7.76	10.01	10.75	2.89
Berkshire Long Island Special		G	3.30	6	7	3
Arlington	4849	F	3.21	7.68	8.40	3.94
Berkshire Potato and Vegetable Phosphate		G	1.70	8	9	2
Arlington	0452	F	2.57	8	8.76	2.22
Berkshire 10-8		G	——	10	11	8
Nassau	4859	F	——	7.68	8.16	8.52
BOWKER FERTILIZER CO., NEW YORK, N. Y.						
Bowker's Empire Special		G	1.65	8	9	3
Clyde	0112	F	1.69	7.72	9.50	3.12

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
BOWKER FERTILIZER CO., NEW YORK, N. Y. (*continued*)						
Bowker's Farm and Garden Phosphate		G*	1.65	8	9	2
Hartwick	6791	F*	1.67	7.60	8.31	2.10
Bowker's Fresh Ground Bone		G	2.47	——	22.88	——
Babylon	6071	F	2.75	——	25.45	——
Bowker's Hill and Drill Phosphate		G	2.47	9	10	2
Groton	6191	F	2.37	9.93	11.70	2
Bowker's Lawn and Garden Dressing, Revised		G	4.94	7	8	3
Elmira	0429	F	4.61	8.23	16.27	2.88
Bowker's Potash Fertilizer		G	0.82	6	7	2
Fairport	6488	F	0.78	6.06	7.20	2.30
Bowker's Potash or Staple Phosphate		G	0.82	8	9	3
Buffalo	0202	F	0.87	7.93	9.01	3.04
Bowker's Potash or Staple Phosphate		G	0.82	8	9	3
Florida	0516	F	0.87	8.14	9.18	3.02
Bowker's Soluble Phosphate		G	——	14	15	——
Mayville	0243	F	——	13.93	15.34	——
Bowker's Special Crop Grower, Revised		G	1.65	10	11	3
Groton	6192	F	1.89	10.31	11.73	3.21
Bowker's Special Crop Grower, Revised		G	1.65	10	11	3
Fairport	6487	F	1.67	9.77	11.61	2.92
Bowker's Special Golden Harvest Fertilizer		G	——	12	13	2
Groton	6194	F	——	13.49	14.82	2.30
Bowker's Special Ideal Potash Compound		G	1.23	10	11	2.5
East Aurora	5997	F	1.27	10.30	11.50	2.47

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
BOWKER FERTILIZER CO., NEW YORK, N. Y. (*concluded*)						
Bowker's Special Potato and Vegetable Fertilizer		G*	2.47	10	11	3
Syracuse	5900	F*	2.06	11.06	12.46	2.76
Bowker's Special Sixteen		G	—	16	17	—
Hunt	6676	F	—	16.06	17.04	—
Bowker's Super Phosphate with Potash		G	—	10	11	2
Fairport	6486	F	—	9.81	10.31	1.90
Bowker's Sure Crop Phosphate		G	0.82	9	10	2
East Aurora	5998	F	0.89	8.94	10.52	1.96
Ground Tankage		G	7.40	—	9.15	—
North Collins	0926	F	7.17	—	9.26	—
High Grade Dried Blood		G	9.87	—	—	—
North Collins	0927	F	10.31	—	—	—
Nitrate of Soda		G	15	—	—	—
Aquebogue	0584	F	15.28	—	—	—
Stockbridge General Crop Manure		G	3.29	8	9	4
New York	0570	F	3.41	8.09	9.05	4.32
Stockbridge Special No. 1		G	4.11	8	9	3
Mount Kisco	0456	F	4.53	8.37	9.21	3.04
Stockbridge Special No. 2		G	3.29	10	11	3
Groton	6193	F	3.53	10.16	11	3.26
BRODE & CO., F. W., MEMPHIS, TENN.						
Cotton Seed Meal		G	—	—	—	—
Owego	6970	F	6.41	0.98	1.70	—
BUTTS, J. P., ONEONTA, N. Y.						
Hustler Special		G	0.82	8	9	3
Oneonta	6767	F	0.89	8.17	9.29	2.96
Potato Manure No. 1		G	2.47	8	9	3
Oneonta	6766	F	2.62	7.35	9.67	3.17

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* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
Carpenter, John M., Elmira, N. Y.						
Carpenter's Tankage		G*	6.57	——	6.93	——
Elmira	0440	F*	6.92	——	9.15	——
Case & Co., A. H., Buffalo, N. Y.						
Case's Complete Fertilizer No. 1, with Manure Filler		G	1.64	8	——	4
Buffalo	5972	F	2.46	8.95	9.63	5
Excelsior Brand Pulverized Pig Manure		G	1	1	——	1
Buffalo	5973	F	2.28	2.50	2.80	1.32
Excelsior Brand Pulverized Pig Manure		G	1	1	——	1
Batavia	0634	F	2.29	2.73	2.95	1.30
Excelsior Brand Pulverized Sheep Manure		G	1	0.87	——	1
Batavia	0633	F	1.92	1.40	1.50	1.47
Chittenden Co., The E. D., Bridgeport, Conn.						
Chittenden's High Grade Potato		G	4.10	8	9	4
Riverhead	0559	F	4.34	8.46	9.96	4.28
Chittenden's Potato Special		G	3.30	8	9	4
Calverton	0573	F	3.52	9.18	10.02	4.04
Chittenden's Special for Corn, Cabbage and Cauliflower		G	4.95	8	9	3
Riverhead	0560	F	5.02	8.43	9.51	3.33
Clark & Son, O. W., Buffalo, N. Y.						
Clark's Velvet Lawn Fertilizer		G	2	5	——	3
Buffalo	0939	F	2.42	8.83	9.77	2.86
Plant Food		G	3.50	7	——	6
Buffalo	0938	F	4.07	8.83	9.99	7.88
Clark, Baylis Co., The, Milford, Conn.						
Clark's Special Potato and Vegetable Fertilizer		G	3.28	8	——	4
Rockville Center	0693	F	3.31	8.19	10.97	4.14

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
CLAY & SON, STRATFORD, LONDON, ENG.						
Clay's Fertilizer		G*	4	1.15	7.20	0.10
New York	0367	F*	4.62	3.42	7.86	0.12
COE-MORTIMER CO., THE, NEW YORK, N. Y.						
E. Frank Coe's Alkaline Phosphate and Potash Special		G	——	14	15	2
Guilford	6928	F	——	14.10	15.22	1.98
E. Frank Coe's Columbian Corn and Potato Fertilizer Special		G	1.23	9	10	2
Little Valley	5984	F	1.12	9.67	11.61	2.30
E. Frank Coe's Corn King Special		G	2.47	10	11	3
Cuba	0210	F	2.28	10.26	11.56	2.90
E. Frank Coe's Empire State Brand Special		G	1.23	10	11	2.50
Guilford	6930	F	1.47	10.31	11.13	2.78
E. Frank Coe's Famous Prize Brand Grain and Grass Fertilizer		G	——	10	11	2
Franklinville	5993	F	——	9.96	11.36	2.04
E. Frank Coe's Gold Brand Excelsior Guano Special		G	2.47	8	9	3
Guilford	6929	F	2.48	7.72	9.50	3.04
E. Frank Coe's High Grade Soluble Phosphate		G	——	14	15	——
Little Valley	5985	F	——	14.98	16.54	——
E. Frank Coe's Natural Grain Fertilizer Special		G	1.65	10	11	3
Cuba	0211	F	1.84	9.95	11.31	3.50
E. Frank Coe's Natural Grain Fertilizer Special		G	1.65	10	11	3
Alabama Center	0645	F	1.74	10.82	12.46	3.01
E. Frank Coe's New England Special Revised		G	0.82	9	10	2
Little Valley	5983	F	1.07	9.03	10.11	2.08

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
COE-MORTIMER CO., THE, NEW YORK, N. Y. (*concluded*)						
E. Frank Coe's Onondaga Special Fertilizer		G*	0.82	7	8	1
Hayt's Corners	0139	F*	0.88	8.17	9.75	1.10
E. Frank Coe's Prolific Crop Producer		G	2.47	9	10	2
Cazenovia	6953	F	2.64	9.86	11.14	2.04
E. Frank Coe's Red Brand Excelsior Guano Special		G	3.29	10	11	3
Lockport	0222	F	3.16	10.92	11.54	3.20
E. Frank Coe's Standard Potato Fertilizer Special		G	3.29	8	9	4
Riverhead	0578	F	3.36	8.65	9.45	4.08
E. Frank Coe's Top Dressing Manure		G	7.41	6	7	3
Interlaken	0131	F	7.00	6.35	7.09	3
E. Frank Coe's Universal Fertilizer		G	1.65	8	9	3
Franklinville	5991	F	1.74	8.44	11.23	3
E. Frank Coe's Western New Yorker Special		G	0.82	9	10	3
Franklinville	5990	F	0.87	9.92	12.14	3
E. Frank Coe's XXV Ammoniated Phosphate		G	0.82	8	9	2
Franklinville	5992	F	1.10	8.27	10.75	2.68
Fine Ground Bone		G	2.47	——	22.88	——
Lockport	0226	F	2.42	——	26.47	——
Nitrate of Soda		G	15	——	——	——
Ontario	0612	F	14.44	——	——	——
Thomas Phosphate Powder (Basic Slag Phosphate) Pulverized		G	——	15†	17	——
Cazenovia	6952	F	——	——	16.70	——

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* These letters indicate, respectively, Guaranteed and Found.

† No official method for determining available phosphoric acid in this sample.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
COLUMBIA GUANO CO., BALTIMORE, MD.						
Columbia Fish, Phosphate and Potash		G*	1.65	8	8.50	3
New Hampton	0534	F*	1.72	9.27	10.83	3.18
Columbia 14% Acid Phosphate		G	——	14	14.50	——
Lodi	0135	F	——	15.03	16.31	——
Columbia Grain Special Fertilizer		G	0.82	8	8.50	2
South Alabama	0647	F	1.18	9.72	11.20	2.28
Columbia Grass and Grain Grower		G	——	10	10.50	2
South Alabama	0646	F	——	10.78	11.70	1.96
Columbia Groso Grain Grower		G	0.82	8	8.50	3
Baldwinsville	031	F	0.96	8.06	9.40	2.76
Columbia High Grade 16% Acid Phosphate		G	——	16	16.50	——
Skaneateles	062	F	——	17.18	17.73	——
Columbia Searchlight Mixture		G	——	12	12.50	2
Earlville	6994	F	——	13.13	14.19	2.03
Columbia Soluble Guano		G	1.65	8	8.50	2
Skaneateles	051	F	1.69	8.58	9.46	1.88
Columbia Strong Hold Guano		G	3.29	10	10.50	3
Borodino	063	F	2.97	10.48	12.10	3.18
Columbia Titanic Guano		G	2.47	8	8.50	3
Chateaugay	3796	F	2.43	8.52	9.90	2.98
CONLEY LIME & FERTILIZER CO., F. E., UTICA, N. Y.						
Evergreen Lawn Dressing		G	1	——	8	——
Utica	6717	F	1.12	——	9.04	——
CONSUMERS CHEMICAL CORPORATION, NEW YORK, N. Y.						
Consumers' Pure Sure Potato and Vegetable with 4% Potash		G	3.29	8	9	4
Hicksville	0686	F	3.88	8	8.56	4.24

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Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
Consumers Chemical Corporation, New York, N. Y. (*concluded*)						
Consumers' Pure Sure Potato Manure with 4% potash		G*	4.12	8	9	4
Riverhead	6076	F*	4.45	8.31	9.15	4.28
Nitrate of Soda		G	14.82	——	——	——
Hicksville	0685	F	14.96	——	——	——
Daniels, Fred, Houghton, N. Y.						
Daniels' Sensible Grain and Grass Grower		G	——	16	17	——
Caneadea	0204	F	——	16.18	16.72	——
Day, Mrs. R. White, Arlington, N. Y.						
Pure Bone and Meat Fertilizer		G	3.05	——	14	——
Arlington	4847	F	5.50	——	14.84	——
Dold Packing Co., Jacob, Buffalo, N. Y.						
Dold Quality Bone Meal		G	2.47	——	23	——
Buffalo	0292	F	2.78	——	23.81	——
Dold Quality Steamed Bone		G	2.46	——	23	——
Buffalo	5978	F	3.60	——	24.80	——
Dold Quality Fertilizer, 1-8-2 Brand.		G	0.82	8	10	2
Buffalo	5976	F	1.28	7.97	9.37	2.28
Dold Quality Fertilizer, 2-8-4 Brand.		G	1.64	8	10	4
Buffalo	5977	F	2.00	8.23	10.07	4.26
Dold Quality Fertilizer. 2-8-10 Brand		G	1.64	8	10	10
Buffalo	5974	F	2.08	7.53	8.61	12.10
Dold Quality Fertilizer, 3-9-2 Brand.		G	2.47	9	10	2
Buffalo	5975	F	2.82	9.47	11.86	2.90
Enterprise Guano Co., Baltimore, Md.						
Enterprise Ammoniated Bone and Potash		G	2.47	8	——	3
New Berlin	6983	F	2.10	8.94	9.50	3.18

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
ENTERPRISE GUANO CO., BALTIMORE, MD. (*concluded*)						
Enterprise Complete Fertilizer		G*	0.82	8	——	2
New Berlin	6985	F*	0.82	9.59	11.05	1.80
Enterprise Corn and Wheat Compound		G	1.65	8	——	2
South Lansing	6988	F	1.54	8.64	9.30	1.89
Enterprise 14% Acid Phosphate		G	——	14	——	——
Sherburne	069	F	——	16.50	16.68	——
Enterprise Grain and Grass Compound		G	——	10	——	2
South Lansing	6990	F	——	10.31	10.65	1.86
Enterprise Grain Mixture		G	0.82	8	——	3
Weedsport	0424	F	0.77	9.70	11.84	4.07
Enterprise Special Complete Manure for All Crops		G	1.65	10	——	3
Weedsport	0422	F	1.34	10.89	11.47	3.19
Enterprise Superior Acid Phosphate		G	——	16	——	——
New Berlin	6984	F	——	16.70	16.80	——
FEDERAL CHEMICAL CO., COLUMBIA, TENN.						
Daybreak Tennessee Brown Phosphate Rock		G	——	——	29.75	——
Syracuse	067	F	——	——	29.30	——
FISCHANG BROS., KINGSTON, N. Y.						
Horse Tankage		G	6.50	——	11	0.25
Kingston	4956	F	7.06	——	12.20	0.48
Kingston Animal Fertilizer		G	6.50	——	11	
Kingston	0707	F	6.85	——	13.17	0.54
GERMAN KALI WORKS, NEW YORK, N. Y.						
Muriate of Potash		G	——	——	——	48
Riverhead	6569	F	——	——	——	47.06

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Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
German Kali Works, New York, N. Y. (*concluded*)						
Sulfate of Potash		G*	—	—	—	47
New York	0364	F*	—	—	—	50.31
Godfrey Co-operative Fertilizer & Chemical Co., Newark, N. J.						
Godfrey's Long Island Potato and Truck Grower		G	3.29	8	8.50	4
Hicksville	0676	F	3.29	7.97	8.65	4.36
Godfrey's Pure Bone Meal		G	2.47	—	23	—
Hicksville	0677	F	2.61	—	23.76	—
Grace & Co., W. R., New York, N. Y.						
Nitrate of Soda		G	15	—	—	—
New York	0366	F	15.16	—	—	—
Griffith & Boyd Co., Baltimore, Md.						
Griffith & Boyd Co.'s Ammoniated Bone Phosphate		G	1.65	8	9	2
Moravia	6568	F	1.74	8.17	9.73	2.12
Griffith & Boyd Co.'s Farmers Potato and Tomato		G	1.25	8	9	3
Moravia	6567	F	1.52	7.76	9.59	3.17
Griffith & Boyd Co.'s Fish, Bone and Potash		G	1.50	7	8	3
Venice Center	0416	F	1.40	7.25	9.35	3.04
Griffith & Boyd Co.'s High Grade Acid Phosphate		G	—	14	15	—
Cuba	0932	F	—	15.21	15.41	—
Griffith & Boyd Co.'s Soluble 12-2		G	—	12	—	2
Merrifield	0414	F	—	12.26	13.22	2.18
Griffith & Boyd Co.'s Special Grain Grower		G	—	10	—	2
Merrifield	0413	F	—	10.98	12.60	2.04
Griffith & Boyd Co.'s Special Royal Guano		G	0.82	8	9	3
Moravia	6569	F	0.89	8.49	10.95	3.17

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Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
Hammond's Slug Shot Works, Beacon, N. Y.						
Hammond's Sward Food		G*	2.35	4.50	5.50	4.60
Beacon	0453	F*	2.51	4.96	5.68	3.57
Haserot Canneries Co., The, Cleveland, O.						
Horsehead Brand, Pulverized Phosphate Untreated Rock		G	——	——	32	——
Brocton	0247	F	——	——	31.70	——
Health Chemical Co., Yonkers, N. Y.						
Dutchess Brand		G	4.50	5.25	7.50	2
Yonkers	0473	F	4.84	5.39	8.75	3.73
Hudson Brand		G	1.50	5.75	8	3
Yonkers	4843	F	1.87	2.70	5.05	0.53
Victor Brand		G	——	2.50	4.75	5
Yonkers	0472	F	——	5.66	8.98	10.76
Westchester Brand		G	0.75	4.75	7	3.75
Yonkers	4844	F	2.44	2.27	4.41	0.70
Henderson & Co., Peter, New York, N. Y.						
Henderson's Fruit and Shade Tree Fertilizer		G	1.65	5	7	10
New York	0391	F	1.96	4.95	8.85	9.84
Henderson's Garden Fertilizer		G	4.12	7	8	5
New York	0379	F	4.68	6.95	8.51	5.92
Henderson's Raw Bone Meal		G	2.47	——	20	——
New York	0381	F	3.94	——	23.60	——
Henderson's Raw Ground Bone		G	2.47	——	20	——
New York	0382	F	3.97	——	23.65	——
Henderson's Special Blood and Bone Fertilizer		G	3.29	——	17	——
New York	0389	F	3.37	——	21.06	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
HENDERSON & CO., PETER, NEW YORK, N. Y. (*concluded*)						
Henderson's Superior Fertilizer for House Plants		G*	4.50	5.50	10	2
New York	0394	F*	4.65	5.91	10.06	2.33
Henderson Worm Killing Grass Food		G	2.36	0.40	0.70	1.80
New York	0388	F	2.75	0.67	0.71	2.06
The Henderson Lawn Enricher		G	2.47	3.50	4.50	2.50
New York	0380	F	2.72	3.87	6.25	3.16
HESS & BRO., S. M., PHILADELPHIA, PA.						
Ammoniated Superphosphate		G	1.65	8	9	2
Jamestown	0241	F	1.51	8	8.90	1.94
Big Crop Fertilizer		G	1.65	10	11	3
Darien Center	6654	F	1.65	10.38	12.04	2.95
Cabbage Manure		G	3.29	6	7	3
Blissville	0661	F	3.32	6.74	8.14	3.31
Climax Alkaline Fertilizer		G	——	14	15	2
Franklinville	0261	F	——	14.82	15.70	1.89
Farmers General Fertilizer		G	0.82	8	9	3
East Williamson	6493	F	0.86	7.90	9.50	3.47
Hess Potato Grower		G	2.88	8	9	4
Hicksville	0678	F	3.05	9.24	10	3.89
High Grade Ground Bone		G	3.29	——	20.59	——
Jamestown	0237	F	3.38	——	20.50	——
High Grade Potato Manure		G	3.29	10	11	3
East Williamson	6494	F	3.21	9.75	11.75	3.26
Keystone Phosphate		G	0.82	8	9	1
Franklinville	0263	F	0.91	8.57	9.85	1.06
Nitrate of Soda		G	15	——	——	——
Blissville	0658	F	15.02	——	——	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
HESS & BRO., S. M., PHILADELPHIA, PA. (*concluded*)						
Soluble Phosphate and Potash		G*	—	10	11	2
Franklinville	0262	F*	—	11.09	11.55	1.75
Special Corn Manure		G	0.82	8	9	2
Jamestown	0239	F	0.91	7.69	9.01	2.22
Special Fish and Potash Mixture		G	2.06	8	9	3
Blissvale	0657	F	2.13	8.59	9.65	3.44
Superior Potato Manure		G	3.29	8	9	4
Laurel	0574	F	3.39	7.85	9.55	4.31
Wheat and Grass Manure		G	0.82	8	9	2
Jamestown	0238	F	0.93	7.73	9.13	2.22
HOLLINGSHURST & CO., NEW YORK, N. Y.						
Fish Scrap		G	9.25	—	6.80	—
Riverhead	0558	F	9.37	—	7.10	—
HUDSON CARBON CO., BALLSTON SPA, N. Y.						
Davidge's Concentrated Manure		G	1	—	1	—
Albany	0712	F	2.35	—	2.15	—
Davidge's Special Phosphorus		G	—	—	5	—
New York	0375	F	—	—	24	—
ICHTHEMIC GUANO CO., THE, IPSWICH.						
Ichthemic Guano		G	3.50	—	—	1.10
New York	0377	F	3.79	8.15	8.25	1.76
INTERNATIONAL AGRICULTURAL CORPORATION, BUFFALO FERTILIZER WORKS, BUFFALO, N. Y.						
Buffalo Animal Tankage		G	6.20	—	10	—
Mount Morris	6678	F	6.62	—	11.81	—
Buffalo Bone Meal		G	2.40	—	22	—
Penn Yan	0115	F	2.43	—	23.50	—
Buffalo Dissolved Phosphate		G	—	14	15	—
Oakfield	6652	F	—	15.65	17.15	—

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
INTERNATIONAL AGRICULTURAL CORPORATION, BUFFALO FERTILIZER WORKS, BUFFALO, N.Y. (*continued*)						
Buffalo Dry Ground Fish		G*	6.60	——	6	——
South Lima	0438	F*	6.05	——	10.62	——
Buffalo Farmers Choice		G	0.80	10	11	2
Fonda	4973	F	0.94	9.91	11.03	2.24
Buffalo Garbage Tankage		G	2.30	——	4	0.70
South Byron	0641	F	2.18	3.70	4.70	0.88
Buffalo Grain Special		G	2	8	9	1.50
Bradford	0407	F	1.72	10.94	11.90	1.56
Buffalo High Grade Manure		G	3.30	8	9	3
Hartwick	6784	F	2.73	8.44	10.10	3.19
Buffalo High Grade Manure		G	3.30	8	9	3
Baldwinsville	065	F	3.30	9.70	11.60	3.16
Buffalo Ideal Wheat and Corn		G	1.60	9	10	2
Fonda	4958	F	1.61	8.86	10.52	2.24
Buffalo Sixteen Per Cent		G	——	16	17	——
South Byron	0640	F	——	17.61	18.15	——
Buffalo Tobacco Producer		G	4.50	5	6	3
Baldwinsville	064	F	4.16	8.14	10.60	3.24
Buffalo Top Dresser		G	5.80	6	7	2
Valois	0132	F	5.63	7.38	8.94	2.30
Buffalo Vegetable and Potato		G	2.40	8	9	3
Hartwick	6785	F	2.23	8.57	10.57	3.08
Buffalo Vegetable and Potato		G	2.40	8	9	3
Industry	0642	F	2.37	9.65	11.39	3.08
Buffalo One-Eight-Two		G	0.80	8	9	2
Johnstown	4974	F	0.81	8.22	9	1.90
Buffalo One-Eight-Three		G	0.80	8	9	3
Oakfield	6653	F	1.20	9.38	10.36	1.84

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
INTERNATIONAL AGRICULTURAL CORPORATION, BUFFALO FERTILIZER WORKS, BUFFALO, N.Y. (*concluded*)						
Buffalo One-Eight-Three		G*	0.80	8	9	3
Johnson	0509	F*	1.18	8.45	9.97	2.90
Buffalo One-Ten-Three		G	0.80	10	11	3
Bath	6558	F	1.60	9.81	11.50	3.52
Buffalo Two-Eight-Three		G	1.60	8	9	3
Industry	0643	F	1.65	10.09	11.79	3.26
Buffalo Two-Eight-Three		G	1.60	8	9	3
Hartwick	6783	F	1.63	9.36	10.52	2.99
Buffalo Two-Eleven-Three		G	1.60	11	12	3
Batavia	6473	F	1.73	11.65	12.69	2.97
Buffalo Ten-Two		G	——	10	11	2
Ontario	0604	F	——	9.90	10.60	1.84
Buffalo Twelve-Two		G	——	12	13	2
South Byron	0639	F	——	12.96	13.70	2.11
Nitrate of Soda		G	15	——	——	——
Copake Iron Works	0482	F	15.62	——	——	——
INTERNATIONAL SEED CO., ROCHESTER, N. Y.						
International Crop Grower		G	0.82	7	8	1
Oneonta	6768	F	0.84	7.67	9.43	1.12
International Electric Fertilizer		G	0.82	8	9	2
Rochester	0302	F	0.91	8.76	10	2
International Grain and Grass Fertilizer		G	1.23	10	11	2.50
Rochester	0303	F	1.38	9.88	11.86	2.56
International Potato and Truck Manure		G	1.65	10	11	3
Oneonta	6769	F	1.77	10.31	12.13	3.16

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
JARECKI CHEMICAL CO., THE, SANDUSKY, O.						
Black Diamond Fish Guano		G*	1.66	8	——	3
Lockport	0224	F*	1.66	7.97	8.73	3.30
Fish and Potash General Grower		G	0.83	9	——	1
Warsaw	6491	F	0.84	8.91	9.41	1.08
Fish and Potash Grain Special		G	0.83	8	——	3
Lockport	0225	F	0.85	8	8.46	3.34
Fish and Potash Truck Manure		G	3.33	9	——	3
Clyde	6600	F	3.28	9.25	9.65	3.28
Fish and Potash Truck Manure		G	3.33	9	——	3
Webster	0610	F	3.22	9.47	10.01	3.40
Humus Phosphate with Potash		G	0.20	10	——	2
Clyde	0101	F	0.27	9.77	10.35	2.08
Lake Erie Guano with Phosphate		G	1.25	9	——	2
and Potash						
Clyde	0102	F	1.24	9.43	10.11	2.28
Lake Erie Guano with Phosphate		G	1.25	9	——	2
and Potash						
Springville	0250	F	1.30	9.90	10.16	2
Raw Bone and Phosphate Mixture		G	1.66	8	——	1
Brocton	0244	F	1.68	14.08	15.80	1.12
JOYNT, JOHN, LUCKNOW, ONTARIO, CANADA						
Canada Unleached Hardwood Ashes		G	——	——	1	2
New York	0393	F	——	——	1.12	3.10
Canada Unleached Hardwood Ashes		G	——	——	1	2
The Joynt Brand						
Whitney Point	5889	F	——	——	1.30	2.56
KELLEY MARCRUM HUMUS CO., STANHOPE, N. J.						
Nitro Humus		G	2.10	1.10	——	0.51
Brooklyn	0807	F	1.41	0.08	0.25	0.27

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* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
Listers Agricultural Chemical Works, Newark, N. J.						
Lister's Ammoniated Dissolved Superphosphate		G*	2.06	8	9	1.50
East Aurora	5999	F*	1.87	7.86	9.82	1.49
Lister's Bone Meal		G	2.67	——	22.88	——
New Rochelle	4837	F	1.82	——	29.10	——
Lister's Bone Meal		G	2.67	——	22.88	——
Patchogue	6064	F	3.40	——	19.55	——
Lister's Buyers Choice Acid Phosphate		G	——	14	15	——
Spencerport	6483	F	——	13.10	13.76	——
Lister's Celebrated Ground Bone and Tankage Acidulated		G	2.67	——	12	——
Patchogue	6063	F	2.58	——	12.37	——
Lister's Complete Potato Grower		G	4.11	8	9	3
Aquebogue	0582	F	3.90	7.96	9	3.98
Lister's Corn and Potato Fertilizer		G	1.65	8	9	3
Moravia	6564	F	1.69	7.86	9.86	2.87
Lister's Ground Tankage		G	4.94	——	13	——
Southampton	6086	F	4.02	——	15.08	——
Lister's High Grade Acid Phosphate		G	——	16	17	——
Moravia	0420	F	——	15.83	17.55	——
Lister's High Grade Dry Blood		G	9.87	——	——	——
Binghamton	6987	F	11.48	——	——	——
Lister's High Grade Grain Grower		G	1.65	10	11	3
Richfield Springs	6788	F	1.58	11.04	11.82	3.30
Lister's Lawn Fertilizer		G	1.65	8	9	3
Peekskill	0471	F	1.90	8.70	10.84	3
Lister's Long Island Potato Manure		G	3.29	10	11	4
Sagaponack	0591	F	3.28	9.85	11.35	4.18

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* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
Lister's Agricultural Chemical Works, Newark, N. J. (*continued*)						
Lister's Long Island Special for Cabbage and Cauliflower		G*	4.11	5	6	4
Hicksville	0689	F*	3.90	4.89	7.35	4.04
Lister's Oneida Special		G	0.82	7	8	1
Utica	6764	F	0.95	6.57	7.55	1.14
Lister's Perfect Potato Manure		G	3.29	8	9	4
Southampton	0587	F	3.26	8.57	9.21	4.02
Lister's Potato Manure Revised		G	3.29	10	11	3
Utica	6765	F	2.94	10.40	11.80	3.36
Lister's Revised Cauliflower and Cabbage Fertilizer		G	3.29	10	11	3
Groton	6190	F	3.24	9.96	11.48	3.28
Lister's Revised Cauliflower and Cabbage Fertilizer		G	3.29	10	11	3
Margaretville	6416	F	3.28	9.72	11.26	3.32
Lister's Revised Grain and Grass Fertilizer		G	——	10	11	2
Spencerport	6484	F	——	9.53	9.95	2.02
Lister's Revised New York Special Fertilizer		G	0.82	9	10	3
Skaneateles	5896	F	0.96	8.19	9.15	2.77
Lister's Revised Celebrated Corn Manure		G	3.29	10	11	3
Huntington	0673	F	3.30	10.37	11.61	3.20
Lister's Revised Potato and Corn No. 2 Fertilizer		G	1.65	10	11	3
St. Johnsville	4968	F	1.78	9.70	12.64	3.12
Lister's Revised Special 10% Potato Fertilizer		G	1.65	10	11	2
South Berlin	4860	F	1.78	10.80	11.80	2.02

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
LISTER'S AGRICULTURAL CHEMICAL WORKS NEWARK, N. J. (*concluded*)						
Lister's Revised Special 10% Potato Fertilizer		G*	1.65	10	11	2
Richfield Springs	6789	F*	1.72	9.91	11.07	2.36
Lister's Revised Vegetable Compound		G	3.29	10	11	3
Huntington	0672	F	3.30	10.15	11.59	3.28
Lister's Special Crop Producer		G	0.82	7	8	1
Spencerport	6482	F	1.01	6.92	8.02	1
Lister's Special Wheat Fertilizer		G	1.65	8	9	3
Phelps	0110	F	1.57	8.36	9.54	3.08
Lister's Standard Pure Superphosphate of Lime		G	2.47	9	10	2
Groton	6189	F	2.65	8.77	11.41	2.39
Lister's Standard Pure Superphosphate of Lime		G	2.47	9	10	2
Utica	6752	F	2.46	9.39	10.85	2.24
Lister's Success Fertilizer		G	1.23	9	10	2
Margaretville	6415	F	1.31	9.25	10.25	2.04
Lister's Success Fertilizer		G	1.23	9	10	2
Moravia	6566	F	1.31	9.08	10.12	2.14
Lister's U. S. Superphosphate		G	1.03	8	9	2
Edmeston	6786	F	1.28	8.26	9.64	2.16
Lister's Valley Brand Fertilizer		G	0.82	8	9	3
Moravia	6565	F	0.97	8.05	9.44	2.82
Lister's Wheat and Rye Fertilizer		G	1.65	8	9	2
Prattsburg	0405	F	1.32	9.51	10.93	1.84
Nitrate of Soda		G	15	——	——	——
Aquebogue	0583	F	15.04	——	——	——
Potato and Corn No. 2		G	1.65	10	11	3
Margaretville	6414	F	1.73	9.80	12.56	2.92

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
LOWELL FERTILIZER CO., BOSTON, MASS.						
Lowell Acid Phosphate		G*	——	14	15	——
Hamilton	6948	F*	——	13.99	15.15	——
Lowell Animal Brand		G	2.46	8	9	3
East Meredith	6418	F	2.30	8.61	9.59	2.93
Lowell Animal Brand		G	2.46	8	9	3
Fort Ann	0301	F	2.53	9.10	9.82	3.24
Lowell Bone Fertilizer		G	1.64	8	9	3
Oneonta	6771	F	1.58	6.94	8.04	2.58
Lowell Bone Fertilizer		G	1.64	8	9	3
East Meredith	6417	F	1.59	8.85	9.73	3.06
Lowell Cereal Fertilizer		G	0.82	7	8	1
Cortland	01	F	1.05	7.77	8.05	1.20
Lowell Dissolved Bone and Potash		G	1.64	9	10	2
Oneonta	6773	F	1.70	10.22	10.88	2
Lowell Empress Brand		G	1.24	7	8	2
Oneonta	6772	F	1.17	7.63	8.33	1.98
Lowell Grain Phosphate		G	——	12	13	2
Middle Granville	4886	F	——	11.24	11.80	1.82
Lowell Ground Bone		G	2.46	——	23	——
Waverly	6945	F	2.47	——	25.15	——
Lowell New York Potato 2-8-3		G	1.64	8	9	3
Brewerton	6906	F	1.70	7.71	9.01	3.40
Lowell New York Special 4-8-3		G	3.28	8	9	3
Middle Granville	4885	F	3.14	7.83	8.75	3.18
Lowell Sterling Phosphate		G	0.82	8	9	3
East Meredith	6419	F	0.87	7.95	8.57	3.85
Nitrate of Soda		G	15	——	——	——
Hamilton	6949	F	15.22	——	——	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
LUDLAM CO., FREDERICK, NEW YORK, N. Y.						
Ludlam's A. B. F. Fertilizer		G*	1.65	8	9	2
Babylon	6070	F*	1.56	8.56	9.86	2.26
Ludlam's Cecrops Fertilizer No. 1		G	3.29	8	9	4
Calverton	6072	F	3.38	8.19	9.15	4
Ludlam's Cecrops Fertilizer Revised		G	3.29	10	11	3
New Woodstock	019	F	3.24	10.59	11.35	3.08
Ludlam's Fruit and Vine Fertilizer Revised		G	1.65	10	11	3
Babylon	6068	F	1.65	9.93	11.25	3.18
Ludlam's Long Island Special Potato Fertilizer Revised		G	2.88	8	9	4
New Hyde Park	0698	F	2.87	8.39	9.71	4.30
Ludlam's Palmetto Fertilizer Revised		G	0.82	8	9	3
New Woodstock	018	F	1.00	8.51	10.15	3
Ludlam's Sickler Phosphate Revised		G	——	10	11	2
Erieville	020	F	——	11.82	13.39	1.98
Ludlam's Special Potato Fertilizer Revised		G	2.47	10	11	3
Babylon	6069	F	2.45	10	11.16	3
Nitrate of Soda		G	15	——	——	——
Calverton	6073	F	15.14	——	——	——
LYON, S. G., AURORA, N. Y.						
S. G. Lyon's Ammoniated Bone Superphosphate		G	1.23	8	9	3
Aurora	0418	F	1.43	8.77	9.51	3.26
MAPES FORMULA & PERUVIAN GUANO CO., THE, NEW YORK, N. Y.						
Mapes General Crop Brand		G	1.65	8	10	2
Mount Kisco	0462	F	2.01	8.27	11.27	2.65

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Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
Mapes Formula & Peruvian Guano Co., The, New York, N. Y. (*continued*)						
Mapes Grain Brand		G*	0.82	8	——	4
Canastota	5895	F*	1.06	8.07	9.87	5.25
Mapes Potato Manure		G	3.71	8	——	6
White Plains	4835	F	3.67	8.87	9.91	6.46
The Mapes Average Soil Complete Manure		G	4.12	7	8	5
Mattituck	6056	F	4.32	7.21	8.65	5.45
The Mapes Cauliflower and Cabbage Manure		G	4.12	6	——	6
Mattituck	6054	F	4.38	6.13	6.89	7.04
The Mapes Cereal Brand		G	1.65	6	8	3
Mount Kisco	0461	F	1.81	6.18	9.54	3.38
The Mapes Complete Manure " A " Brand		G	2.47	10	12	2.50
Mount Kisco	0463	F	2.85	9.52	13.20	2.80
The Mapes Complete Manure 10% Potash		G	2.06	3	5	10
Canastota	5894	F	2.50	3.94	5.62	10.66
The Mapes Corn Manure		G	2.47	8	10	6
Manorville	6088	F	2.55	7.46	11.46	6.26
The Mapes Dissolved bone		G	2.06	12	——	——
Mattituck	6055	F	2.50	16.19	18.47	——
The Mapes Economical Potato Manure		G	3.29	4	6	8
Hicksville	0690	F	3.38	4.22	7.28	9.16
The Mapes Fruit and Vine Manure		G	1.65	5	7	10
Manorville	6087	F	1.81	4.82	8.04	11.37
The Mapes Potato Manure L. I. Special		G	3.29	4	6	7
Manorville	6090	F	3.30	5.72	7.96	7.15

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
MAPES FORMULA & PERUVIAN GUANO CO., THE, NEW YORK, N. Y. (*concluded*)						
The Mapes Tobacco Ash Constituents		G*	0.50	——	5.70	15
Owego	6972	F*	0.58	2.29	5.78	16.09
The Mapes Tobacco Starter Improved		G	4.12	6	8	1
Owego	6971	F	4.12	7.24	9.24	2.93
The Mapes Top Dresser Improved Full Strength		G	9.88	5	8	4
Mattituck	6060	F	9.88	6.51	8.01	5.09
The Mapes Top Dresser Improved Half Strength		G	4.94	2.50	4	2
White Plains	4834	F	5.14	3.50	4.55	2.12
The Mapes Vegetable Manure or Complete Manure for Light Soils		G	4.94	6	8	6
Irvington	0469	F	5.33	7.13	9.19	6.80
MARTIN FERTILIZER CO., PHILADELPHIA, PA.						
Acid Phosphate		G	——	14	——	——
Kendaia	0125	F	——	14.85	15.05	——
Dissolved Organic Compound		G	1.03	9	——	2
Romulus	0128	F	1.59	11.35	12.71	2.51
Martin's Corn and Cereal Special		G	1.64	8	——	2
Syracuse	6996	F	1.85	9.35	01.31	2.51
Special Compound		G	1.64	8	——	5
Rushville	0148	F	1.79	10.14	11.06	4.51
Special Mixture		G	1.64	8	——	3
Seneca Falls	6595	F	1.75	9.14	10.70	3.37
One-Eight-Three		G	0.82	8	——	3
Seneca Falls	6597	F	1.00	9.81	10.75	3.42

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
MARTIN FERTILIZER CO. PHILADELPHIA, PA. (*concluded*)						
One-Eight-Three		G*	0.82	8	——	3
Romulus	0129	F*	1.20	10.82	11.50	3.13
Two-Ten-Five		G	1.64	10	——	5
Seneca Falls	6596	F	1.65	10.30	11.40	3.84
Four-Eight-Five		G	3.28	8	——	5
Rushville	0147	F	3.14	8.58	10.22	3.71
Four-Ten-Three		G	3.28	10	——	3
Liverpool	6997	F	2.79	10.55	11.16	2.67
MITCHELL FERTILIZER CO., THE, TREMLEY, N. J.						
Mitchell's Vegetable Fertilizer		G	2.47	8	9	3
Kinderhook	0487	F	2.56	7.98	9.10	3.35
MUNROE & SON, GEO. L., OSWEGO, N. Y.						
Pure Unleached Wood Ashes		G	——	0.25	0.50	1
Kirkwood	6956	F	——	0.63	1.11	2.96
MCCOY, GEO. E., PEEKSKILL, N. Y.						
An Honest Fertilizer		G	5	——	16	——
Peekskill	4838	F	5.01	——	20.36	——
NASSAU FERTILIZER CO., NEW YORK, N. Y.						
Big Yield		G	1.65	9	10	3
Lowville	6710	F	1.65	9.88	10.74	2.89
Gladiator Truck and Potato Special		G	3.29	10	11	3
Candor	6958	F	3.39	10.76	11.20	3
Grass and Grain Fertilizer		G	——	10	11	2
Shekomeko	0478	F	——	9.37	10.61	1.84
Plow Brand		G	1.65	8	9	2
Lowville	6709	F	1.71	8.22	9.36	2.20
Potato Manure		G	2.06	8	9	3
Shekomeko	0477	F	2.03	8.39	9.25	3.08

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* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
Nassau Fertilizer Co., New York, N. Y. (*concluded*)						
Soluble Phosphate		G*	——	14	15	——
Lowville	6712	F*	——	15.39	16.39	——
Special General Favorite		G	0.82	8	9	3
Lowville	6711	F	1.04	8.98	9.76	3.09
Wheat and Grass Grower		G	0.82	8	9	2
Gayhead	0709	F	1.09	8.94	9.86	2
National Fertilizer Co., The, New York, N. Y.						
National Ammoniated Bone Phosphate		G	1.65	8	9	2
Patchogue	6065	F	1.80	8.10	10.06	2.31
National Complete Root and Grain Fertilizer Special		G	3.29	8	9	4
Southampton	0590	F	3.13	7.93	9.85	4.14
National Potato Phosphate Special		G	2.06	8	9	3
Eastport	6082	F	2.05	8.93	10.55	3.58
Natural Guano Co., Aurora, Ill.						
Sheep's Head Brand Pulverized Sheep Manure		G	2.25	1	1.25	1.50
New York	0374	F	2.51	1.79	1.93	1.84
Newburgh Rendering Co., Newburgh, N. Y.						
Concentrated Tankage		G	11	——	——	——
Newburgh	0702	F	11.95	——	——	——
Pure Meat and Bone Fertiliser		G	4	——	16	——
Newburgh	0701	F	5.35	——	17.12	——
Newhof & Son, L., Albany, N. Y.						
Pure Fertiliser		G	5	——	9	——
Albany	0710	F	6.87	——	7.43	——
N. J. Fertilizer & Chemical Co., New York, N. Y.						
Croxton Complete Truck Guano		G	3.35	8	10.50	5
Ronkonkoma	6091	F	2.98	8.44	8.73	4.18

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
NEW YORK STABLE MANURE CO., JERSEY CITY, N. J.						
Diamond Dried Ground Compost		G*	2.06	1.50	1.79	1
New York	0392	F*	2.38	1.97	2.35	1.43
NEW YORK STATE GRANGE PURCHASING AGENCY, OLEAN, N. Y.						
Patron's		G	——	8	——	3
Baldwinsville	032	F	——	7.61	8.60	2.40
Patron's 1-9-3		G	0.82	9	9.50	3
Alden	0936	F	1.01	9.08	9.66	2.72
Patron's 2-8-2		G	1.64	8	8.50	2
Alden	0935	F	1.64	8.63	9.45	1.55
Patron's 3-10-3		G	2.46	10	10.50	2
Thiells	0703	F	2.29	10.48	11.10	2.06
Patron's 3-10-3		G	2.46	10	10.50	3
Thiells	0706	F	2.15	10.33	10.73	2.20
Patron's 4-8-3		G	3.26	8	8.50	3
Linwood	6665	F	3.15	8.01	8.65	2.86
Patron's 4-8-3		G	3.29	8	8.50	3
Alden	0937	F	3.12	9.30	10.32	2.86
Patron's 4-9-3		G	3.28	9	9.50	3.00
Thiells	0705	F	2.96	8.82	9.63	2.60
Patron's 7-6-2		G	5.74	6.	6.50	2
Thiells	0704	F	5.76	7.34	8.26	2.12
14% Acid Phosphate		G	——	14.	14.25	——
Rochester	6666	F	——	14.51	14.79	——
14% Acid Phosphate		G	——	14	14.30	——
Kings Park	0806	F	——	13.90	15.50	——
16% Acid Phosphate		G	——	16	16.30	——
Linwood	6664	F	——	16.41	17.29	——

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
NEW YORK STATE GRANGE PURCHASING AGENCY, OLEAN, N. Y. (*concluded*)						
16% Acid Phosphate		G*	—	16	16.30	—
Morganville	6675	F*	—	16.03	17.35	—
16% Acid Phosphate		G	—	16	16.38	—
Alden	0934	F	—	16.58	17.34	—
NITRATE AGENCIES CO., NEW YORK, N. Y.						
Basic Slag (Thomas Phosphate Powder)		G	—	†14	17	—
New York	0361	F	—	—	17.05	—
Dried blood		G	13.16	—	—	—
New York	0357	F	12.60	—	—	—
Ground Bone		G	2.46	—	22.88	—
Brooklyn	0356	F	2.46	—	24.25	—
High Grade Acid Phosphate		G	—	16	—	—
New York	0354	F	—	15.99	16.41	—
High Grade Acid Phosphate		G	—	14	—	—
New York	0355	F	—	14.72	15.04	—
High Grade Chemical Fertilizer		G	4.93	8	—	6
New York	0358	F	5.20	8.96	9.72	5.94
High Grade Genuine Peruvian Guano		G	10.69	10	11	2
New York	0360	F	10.53	11.07	13.07	2.58
High Grade Raw Bone		G	3.70	—	23	—
New York	0359	F	3.68	—	24.68	—
Nitrate Soda		G	15	—	—	—
New York	0365	F	15.24	—	—	—
OLDS & WHIPPLE, HARTFORD, CONN.						
Castor Pomace		G	5	—	1.65	0.90
Baldwinsville	6999	F	5.35	—	1.53	0.68

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* These letters indicate, respectively, Guaranteed and Found.

† No official method for determining available phosphoric acid in this sample.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
OLDS & WHIPPLE, HARTFORD, CONN. (*concluded*)						
Castor Pomace		G*	5	——	1.65	0.90
Baldwinsville	034	F*	5.13	——	1.53	0.86
Olds & Whipple's Dry Ground Fish		G	7.40	4.50	5.50	——
Baldwinsville	6998	F	8.67	5.31	6.81	——
Olds & Whipple's Precipitated Bone Phosphate		G	——	——	38	——
Baldwinsville	7000	F	——	——	40.70	——
PATAPSCO GUANO CO., BALTIMORE, MD.						
Coon Brand Guano		G	0.82	9	10	3
Oxford	6912	F	1.19	9.53	10.65	3.25
Grange Mixture		G	1.65	8	9	2
Bridgewater	6797	F	1.79	7.86	9.34	2.18
Patapsco Golden Crop Fertilizer		G	1.65	9	10	3
Oxford	6911	F	1.84	9.25	10.92	3.16
Patapsco O. K. Phosphate		G	0.82	8	9	2
Oxford	6910	F	0.87	9.61	9.89	2.10
Patapsco Pure Dissolved S. C. Phosphate		G	——	14	15	——
Bridgewater	6796	F	——	13.72	14.48	——
Patapsco Soluble Phosphate and Potash		G	——	10	11	2
New Berlin	6947	F	——	10.55	11.71	1.96
Patapsco Special Alkaline Phosphate		G	——	12	13	2
Oxford	6914	F	——	12.20	12.70	2.35
Patapsco Special Columbian Guano for Truck, Potatoes and Tobacco		G	2.47	8	9	3
Oxford	6913	F	2.53	7.39	9.77	3.10
Patapsco Special Prolific Potato Phosphate		G	3.29	10	11	3
Bridgewater	6798	F	3.30	10.13	11.37	3.10

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Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
Piedmont-Mt. Airy Guano Co., Baltimore, Md.						
Insula Guano for All Crops		G*	0.42	7	——	2
Holland	0269	F*	0.46	7.66	8.10	2.08
Levering's Ammoniated Bone		G	0.82	9	——	3
Sodus Center	6598	F	0.77	9.28	9.80	3.61
Levering's Harvest Queen		G	0.82	8	——	2
Cortland	6179	F	1.08	8.16	9	2.53
Levering's Standard		G	1.65	8	——	3
Cortland	6184	F	1.63	7.81	8.61	3.14
Nitrate of Soda		G	15.23	——	——	——
Hicksville	0688	F	15.32	——	——	——
Piedmont 14% Acid Phosphate		G	——	14	——	——
Nichols	6944	F	——	16.22	16.35	——
Piedmont 14% Acid Phosphate		G	——	14	——	——
Clyde	0105	F	——	15.58	15.66	——
Piedmont Grain and Grass Grower		G	1.25	9	——	2.50
Atwater	0419	F	1.23	8.94	9.72	3.50
Piedmont Grain and Grass Grower		G	1.25	9	——	2.50
Spencer	6974	F	1.35	9.62	10.14	2.98
Piedmont High Grade Ammoniated Bone and Potash		G	2.47	8	——	3
Cortland	6178	F	2.34	8.25	9.13	3.16
Piedmont New York Potato and Truck		G	4.12	8	——	4
Riverhead	0585	F	3.93	8.30	8.96	4.43
Piedmont Oats and Grass Guano		G	——	10	——	2
Ontario	0607	F	——	10.16	10.50	2.30
Piedmont Raw and Dissolved Bone		G	2.47	10	23	——
Holland	0268	F	2.50	15.15	22.05	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
PIEDMONT-MT. AIRY GUANO CO., BALTIMORE, MD. (*concluded*)						
Piedmont 16% Acid Phosphate		G*	—	16	—	—
Holland	0272	F*	—	17.38	17.50	—
Piedmont Special Complete Fertilizer		G	2.47	8	—	4
Riverhead	0586	F	2.75	7.97	8.65	4.16
Piedmont Special Market Garden Manure		G	3.29	8	—	2
Cortland	6185	F	3.11	8.76	9.80	2.14
Piedmont Special Perfection Fertilizer		G	1.65	10	—	3
Owego	6916	F	1.66	10.88	12.18	3.28
Piedmont Special Phosphate and Potash Mixture		G	—	13	—	2
Groton	6993	F	—	13.40	13.45	3.50
Piedmont Special Phosphate and Potash Mixture		G	—	13	—	2
Livonia Center	0436	F	—	15.11	15.21	2.01
Piedmont Special Potato Guano		G	3.29	8	—	4
Hicksville	0681	F	3.00	8.49	9.09	4.06
Piedmont Wheat and Corn Guano		G	1.65	8	—	2
Ontario	0608	F	1.51	8.74	9.29	2.16
PINE & SON, B. J., EAST WILLISTON, L. I.						
Pine's No. 2 Star Raw Bone Superphosphate and Complete Manure, Revised		G	2.06	8	9	3
East Williston	0694	F	2.25	8.18	9.52	3.26
PULVERIZED MANURE CO., THE, CHICAGO, ILL.						
Wizard Brand Pulverized Sheep Manure		G	1.80	1	—	1
New York	0376	F	2.33	1.43	1.45	2.03

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* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
Quaker City Poudrette Co., Philadelphia, Pa.						
Quaker City Poudrette		G*	1.50	——	3	0.48
New York	0399	F*	1.20	——	3.44	0.31
Radium Fertilizer Co., Pittsburg, Pa.						
Radium Brand Fertilizer		G	3.30	10	——	3
Rochester	0433	F	3.45	10.49	10.89	3.12
Rasin Monumental Co., Baltimore, Md.						
Rasin's Acid Phosphate		G	——	14	15	——
Cobleskill	0304	F	——	15.06	15.70	——
Rasin's Big Sixteen Alkaline Compound		G	——	16	17	2
Collins	0283	F	——	16.80	18.06	2.29
Rasin's Bone and Potash Fertilizer		G	——	10	11	2
Amsterdam	4963	F	——	10.01	11.45	2.28
Rasin's Capital Crop Compound		G	0.82	9	10	3
Moravia	6563	F	0.98	9.32	10.03	3.02
Rasin's Champion Potato and Vegetable Manure		G	3.29	8	9	3
Le Roy	6472	F	3.22	8.27	9.16	3.40
Rasin's Champion Potato and Vegetable Manure		G	3.29	8	9	3
Stanley	0113	F	3.08	8.99	9.63	3.14
Rasin's Electric Truck and Vegetable Compound		G	4.12	8	9	3
Salamanca	0291	F	3.85	8.82	9.40	2.78
Rasin's Empire Guano		G	1.65	8	9	2
Amsterdam	4962	F	1.81	8.03	8.87	2.48
Rasin's Great Alkaline Grain Grower		G	——	14	15	2
Linwood	6471	F	——	13.83	14.67	2.64

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COL SIONER OF AGRICULTURE DURING 1915 (

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		Pot
			Nitrogen
RASIN MONUMENTAL CO., BALTIMORE, MD. (*concluded*)			
Rasin's Great Alkaline Grain Grower		G*	—
Fairport	0625	F*	—
Rasin's Great Ammoniated Crop Compound		G	0.82
Amsterdam	4965	F	1.00
Rasin's Home Run Guano		G	1.65
Stanley	6500	F	1.76
Rasin's Home Run Guano		G	1.65
Penn Yan	6591	F	1.81
Rasin's Honey Bee Guano		G	0.82
Le Roy	6662	F	0.97
Rasin's King Guano		G	2.06
Amsterdam	4964	F	2.02
Rasin's Royal Fish, Bone and Potash		G	1.65
Boonville	6754	F	1.83
Rasin's 16% Acid Phosphate		G	—
Le Roy	6661	F	—
Rasin's United Grain Grower		G	0.82
Florida	0502	F	0.89
Rasin's Victoria Phosphate and Potash		G	—
Penn Yan	6592	F	—
READING BONE FERTILIZER CO., READING, PA			
Blood, Meat and Potash Mixture		G	1.64
Hamburg	0277	F	1.89
Farmer's Tankage and Potash for Corn, Grain and Grass		G	0.82
Churchville	0631	F	0.81

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* These letters indicate, respectively, Guaranteed and Fou

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
READING BONE FERTILIZER CO., READING, PA. (*concluded*)						
14% Clear Acid Phosphate		G*	——	14	15	——
South Alabama	0648	F*	——	15.24	16.06	——
Gilt Edge Potato and Tobacco Grower		G	1.64	12	13	3
Honeoye Falls	6674	F	1.49	12.47	13.41	3.18
High Grade Potash Mixture		G	——	14	15	2
Hamburg	0279	F	——	15.33	16.11	1.86
Reading All Crops Special		G	1.64	10	11	3
Hamburg	0280	F	1.65	10.22	11	3.02
Reading Prize Winner		G	2.46	9	10	3
Hamburg	0278	F	2.53	10.22	11.40	2.73
REEVES CO., R. C., NEW YORK, N. Y.						
Reeves' Phospho-Peruvian Guano		G	2.47	9	10	3
New York	0802	F	2.57	9.16	10.31	2.26
REICHARD, ROBERT A., ALLENTOWN, PA.						
Golden Harvest Phosphate		G	1.64	8	10	5
Johnson	0507	F	1.68	7.02	9.85	5.81
Peerless Phosphate		G	0.82	8	9	4
Johnson	0508	F	0.95	7.62	9.50	4.61
ROGERS & HUBBARD CO., THE, PORTLAND, CONN.						
Hubbard's " Bone Base " All Soils-All Crops Phosphate		G	3.30	8	9	2.50
Jay	0863	F	3.12	7.80	9.68	2.64
Hubbard's " Bone Base " Complete		G	1.50	7	8	1.66
Phosphate	0460	F	1.35	7.72	10.36	1.72
Hubbard's " Bone Base " Fertilizer for Oats and Top Dressing		G	8.50	——	8	4
Mount Kisco	0457	F	7.82	——	9.82	3.39
Hubbard's " Bone Base " Fertilizer for Seeding Down and Fruit		G	2.20	6.50	16	4
East Chatham	0483	F	2.19	9.12	16.70	4.64

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
ROGERS & HUBBARD CO., THE, PORTLAND CONN. (*concluded*) Hubbard's "Bone Base" Potato Phosphate		G*	2	9	10	2.25
Mount Kisco	0458	F*	1.92	10.26	11.22	2.46
Hubbard's "Bone Base" Soluble Corn and General Crops Manure		G	2.50	6	8	3
Mount Kisco	0459	F	2.74	7.72	10.14	3.08
Hubbard's "Bone Base" Soluble Potato Manure		G	5	7	10	2
East Chatham	0485	F	4.57	6.38	10.68	2.44
Hubbard's "Bone Base" Soluble Tobacco Manure		G	5	7	10	3.33
East Chatham	0484	F	4.94	7.06	11.22	3.66
ROYSTER GUANO CO., F. S., BALTIMORE, MD. Nitrate of Soda		G	15	——	——	——
Deposit	6934	F	15.41	——	——	——
Royster's Cloverdale Grain and Grass Grower		G	——	10	10.50	2
Amsterdam	4966	F	——	10.87	11.81	2.24
Royster's Corn and Hop Special Fertilizer		G	2.06	8	8.50	3
Edmeston	6782	F	2.00	7.82	9.08	3.22
Royster's Cuckoo Crop Grower		G	0.82	8	8.50	1
Florida	0535	F	1.04	9.36	10.38	1.08
Royster's Dreadnought Fertilizer		G	1.65	8	8.50	2
Amsterdam	4967	F	1.83	8.57	9.77	2.14
Royster's Eldorado Compound		G	1.65	10	10.50	3
Delevan	0266	F	1.63	10.69	11.85	2.83
Royster's Favorite Compound		G	1.65	10	10.50	2
Port Byron	0417	F	1.69	10.18	11.42	2.12

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
ROYSTER GUANO CO., F. S., BALTIMORE, MD. (*continued*)						
Royster's Fine Ground Bone Meal		G*	2.47	——	22.90	——
West Valley	0920	F*	4.07	——	22.88	——
Royster's Fish, Flesh and Fowl		G	1.65	8	8.50	3
Cortland	6182	F	1.79	8.52	9.72	3.18
Royster's 14% Acid Phosphate		G	——	14	14.50	——
Fayetteville	6905	F	——	15.55	16.81	——
Royster's Harmony Compound		G	——	12	12.50	2
Corfu	0638	F	——	12.97	13.85	1.98
Royster's H. G. 16% Acid Phosphate		G	——	16	16.50	——
Cortland	6186	F	——	16.31	17.15	——
Royster's Martial Compound		G	3.29	10	10.50	3
Cortland	6187	F	3.34	10.76	12.30	3.16
Royster's Normal Compound		G	4.94	8	8.50	3
Riverhead	6077	F	4.78	8.22	10.58	3.08
Royster's Parfait Compound		G	4.11	8	8.50	4
Riverhead	0556	F	4.08	8.06	10.00	4.19
Royster's Pure Raw Bone Meal		G	3.70	——	21.50	——
New Rochelle	0465	F	3.76	——	22.00	——
Royster's Seeding Down Special Fertilizer		G	0.82	9	9.50	3
Groton	6188	F	0.97	9.82	10.98	3
Royster's Truckers Delight		G	3.29	8	8.50	4
Riverhead	0557	F	3.43	8.06	10.02	3.98
Royster's Utopia Compound		G	2.47	8	8.50	3
Jamestown	5996	F	2.37	8.25	9.61	2.82
Royster's Walhalla Compound		G	1.23	9	9.50	1.50
Edmeston	6781	F	1.18	9.39	10.65	1.42
Royster's Wheat, Oats and Barley Fertilizer		G	0.82	8	8.50	2
Cortland	6177	F	1.00	8.81	9.81	1.97

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
Royster Guano Co., F. S., Baltimore, Md. (*concluded*)						
Royster's Wonder Worker Guano		G*	0.82	8	8.50	3
Tully	015	F*	1.02	8.22	9.34	2.91
Sander, Adam, Salamanca, N. Y.						
Adam Sander Dry Tankage Fertilizer		G	5.38	6	15.40	——
Salamanca	0930	F	4.31	8.41	19.95	——
Sanderson Fertilizer & Chemical Co., New Haven, Conn.						
Nitrate of Soda		G	15	——	——	——
Hicksville	0680	F	15.44	——	——	——
Sanderson Special Cabbage Fertilizer		G	4.12	9	10	4
Hicksville	0687	F	4.18	9.28	10.30	4.25
Sanderson Special Potato Manure Revised		G	3.30	8	9	4
Hicksville	0679	F	3.30	7.87	9.69	4.53
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.						
Dissolved Phosphate		G	——	14	15	——
Pavilion	6660	F	——	14.54	15.70	——
Dissolved Phosphate and Potash		G	——	10	11	2
Pavilion	6658	F	——	10.70	10.86	1.96
Farmers' Favorite		G	0.82	8	9	2
Randolph	0233	F	0.82	7.78	9	1.91
Fireside Phosphate		G	3.29	6	7	3
Pavilion	6657	F	3.28	6.88	8.60	2.92
Grass Wheat and Oats		G	1.23	10	11	2.50
Pavilion	6656	F	1.33	10.75	11.85	2.45
Guano Special		G	0.82	8	9	3
South Dayton	0285	F	0.85	7.90	9.52	3.36
High Grade Ground Bone		G	3.29	——	20.59	——
South Dayton	0284	F	3.39	——	20.48	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
SCHAAL-SHELDON FERTILIZER CO., BUFFALO, N. Y. (*concluded*)						
Schaal's Corn and Potato Special		G*	1.65	8	9	3
Randolph	0234	F*	1.65	7.75	9.35	3.06
Truckers' Manure Special		G	2.47	8	9	3
Randolph	0235	F	2.49	7.80	9.42	2.88
SHAY FERTILIZER CO., THE C. M., GROTON, CONN.						
Nitrate of Soda		G	——	——	——	——
Jamesport	0600	F	14.99	——	——	——
Shay's Formula		G	3.20	6	8	4
Jamesport	6051	F	3.23	7.35	8.85	5
Tankage		G	——	——	——	——
Jamesport	0599	F	5.21	——	——	——
SHOEMAKER & CO., LTD., M. L., PHILADELPHIA, PA.						
Swift-Sure Bone Meal		G	4.53	——	20	——
Southampton	6085	F	5.38	——	23.05	——
Swift-Sure Guano for Truck, Corn and Onions		G	2.50	8	——	3
Southampton	6083	F	1.86	9.12	11.14	5.51
Swift-Sure Superphosphate for Potatoes		G	3.29	8	——	3
Southampton	6084	F	3.40	10.97	12.11	3.90
STANDARD GUANO CO., BALTIMORE, MD.						
Dried Blood		G	6.56	——	——	——
Nineveh	6967	F	10.00	——	——	——
Extra High Grade Acid Phosphate		G	——	16	——	——
Tunnel	6943	F	——	16.93	17.55	——
Ground Tankage		G	8.24	——	——	——
Binghamton	6964	F	8.70	——	——	——
Nitrate of Soda		G	12.30	——	——	——
Nineveh	6968	F	14.92	——	——	——

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* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
Standard Guano Co., Baltimore, Md. (*concluded*)						
16% Acid Phosphate		G*	——	16	16.30	——
Olean	014	F*	——	16.06	16.46	——
Standard High Grade Acid Phosphate		G	——	14	——	——
Fultonville	4959	F	——	14.64	15.46	——
Standard Old Fertility		G	1.64	8	——	3
Nineveh	6965	F	1.55	8.36	9.21	2.61
3-8-3		G	2.46	8	——	3
Nineveh	6966	F	2.09	8.04	9.09	2.35
Stappenbeck & Sons, H., Utica, N. Y.						
Animal Bone and Potash		G	2.50	8	15	2.50
Whitesboro	6763	F	2.54	10.63	19.55	2.75
Stockwell Co., J. W., Fillmore, N. Y.						
Stockwell Co's Home Mixed 1-13-5 Fertilizer		G	0.82	13	——	5
Fillmore	0205	F	0.86	14.21	14.85	4.30
Stockwell Co's Home Mixed 2-12-5 Fertilizer		G	1.65	12	——	5
Fillmore	0207	F	1.64	12.42	12.66	5.26
Stockwell Co's Home Mixed 4-10-5 Fertilizer		G	3.29	10	——	5
Fillmore	0206	F	2.99	10.79	11.61	4.84
Stockwell Co's 16% Acid Phosphate		G	——	16	——	——
Fillmore	0208	F	——	15.96	16.30	——
Stonemeal Fertilizer Co., Inc., North Paterson, N. J.						
Stonemeal		G	——	——	10.12	10.42
Bliss	6670	F	——	——	3.47	0.09
Stonemeal		G	——	——	10.12	10.42
Canastota	058	F	——	——	4.20	0.05
Stonemeal		G	——	——	10.12	10.42
Ravena	0713	F	——	——	4.76	0.07

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
STONEMEAL FERTILIZER CO., INC., NORTH PATERSON, N. J. (*concluded*)						
Stonemeal		G*	—	—	10.12	10.42
Andover	0940	F*	—	—	4.36	0.01
Stonemeal		G	—	—	10.12	10.42
Grand Island	0944	F	—	—	4.12	0.00
Stonemeal		G	—	—	10.12	10.42
Poughkeepsie	4846	F	—	—	3.08	Trace
Stonemeal		G	—	—	—	—
Dunkirk	5979	F	—	—	4.58	0.12
Stonemeal		G	—	—	10.12	10 42
Baldwinsville	066	F	—	—	3.76	0.19
Stonemeal		G	—	—	—	—
Chili	0431	F	—	—	4.74	0.04
STUMPP & WALTER CO., NEW YORK, N. Y.						
Emerald Lawn Dressing		G	3	5	6	2.50
New York	0653	F	3.64	6.36	7.48	2.93
S. & W. Co's Bone Fertilizer		G	3	—	20	—
New York	0652	F	3.08	—	23.67	—
SWIFT & CO., BALTIMORE, MD.						
Riverhead Town Agr'l Society Fertilizer 1915 Formula No. 3		G	3.29	8	—	4
Laurel	0576	F	3.14	8.90	8.92	3.76
Special Bone Meal		G	1.03	—	28	—
Union	6979	F	1.30	—	29.27	—
Swift's Champion Wheat and Corn Grower		G	1.65	12	—	2
Windsor	6973	F	1.65	11.31	12.25	2.23
Swift's Corn, Wheat & Oats Special		G	0.82	11	—	3
Candor	6922	F	0.92	10.46	11.96	2.85

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
SWIFT & CO., BALTIMORE, MD. (*continued*)						
Swift's Degelatinized Bone		G*	——	——	——	——
Dryden	6977	F*	1.15	——	28.01	——
Swift's Pure Animal Fertiliser Long Island Special		G	4.94	8	——	4
Aquebogue	0575	F	4.89	7.72	8.56	4.30
Swift's Pure Bone Meal		G	2.47	——	24	——
Cattaraugus	5982	F	2.79	——	22.15	——
Swift's Pure Corn and Wheat Grower		G	1.65	10	——	2
Herkimer	6780	F	1.70	9	10.36	2.15
Swift's Pure Degelatinized Bone		G	0.82	——	28	——
Ballston Spa	0714	F	1.32	——	31.48	——
Swift's Pure Diamond A Vegetable, Tobacco and Fruit Grower		G	2.47	8	9	3
Cortland	6180	F	2.53	8.91	9.69	3.06
Swift's Pure Diamond K Grain Grower		G	0.82	12	12.50	1
Burt	0228	F	0.87	12.27	12.69	1.16
Swift's Pure Diamond W Vegetable and Fruit Grower		G	1.65	8	9	3
Cattaraugus	5980	F	1.71	7.91	9.29	3.20
Swift's Pure Diamond Z Fertilizer		G	0.82	11	——	1
Candor	6921	F	0.78	10.89	12.59	0.90
Swift's Pure Dissolved Animal Bone with Potash		G	1.23	13	18	1.50
Burt	0229	F	1.23	12.92	17.39	1.50
Swift's Pure Florist Special Tankage		G	4.94	——	12	——
Tarrytown	0468	F	5.95	——	13.16	——
Swift's Pure Garden City Phosphate		G	——	14	——	——
Canajoharie	4960	F	——	14.02	15.06	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
SWIFT & CO., BALTIMORE, MD. (*continued*)						
Swift's Pure Garden City Phosphate		G*	——	14	——	——
Cherry Valley	0311	F*	——	16.20	16.40	——
Swift's Pure Ground Beef Bone		G	2.06	——	27	——
Sinclairville	0917	F	2.04	——	27.31	——
Swift's Pure Long Island Potato Manure		G	3.29	8	——	4
Aquebogue	0581	F	3.09	7.74	8.66	4.69
Swift's Pure Market Garden Manure		G	3.29	8	——	3
Chester	0524	F	3.16	7.88	9.06	3.78
Swift's Pure Nitrate of Soda		G	14.81	——	——	——
Cuba	0212	F	15.44	——	——	——
Swift's Pure Pulverized Sheep Manure		G	1.65	——	1	1.50
Burt	0227	F	1.66	——	1.75	2.96
Swift's Pure Red Steer		G	1.65	8	9	2
Cortland	6181	F	1.87	8.06	9.26	2.16
Swift's Pure Regal Top Dresser		G	8.24	5	——	3
Sidney	6446	F	6.60	5.80	6.81	3
Swift's Pure Regal Top Dresser		G	8.24	5	——	3
Apalachin	6963	F	7.64	5.42	6.04	2.73
Swift's Pure Reliable Grain Fertilizer		G	0.82	8	——	1
Cherry Valley	0310	F	0.64	7.79	8.83	0.81
Swift's Pure Special Corn, Wheat and Grain Fertilizer		G	0.82	8	——	3
Romulus	0140	F	0.79	8.34	9.26	2.86
Swift's Pure Special Formula for Tobacco		G	4.50	3	——	5.50
Apalachin	6962	F	4.38	3.06	3.72	5.78

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
SWIFT & CO., BALTIMORE, MD. (*concluded*)						
Swift's Pure Special High Grade Acid Phosphate		G*	——	16	——	——
Romulus	0141	F*	——	17.53	18.79	——
Swift's Pure Special Phosphate and Potash		G	——	10	——	2
Canajoharie	4961	F	——	9.52	10.04	1.82
Swift's Pure Superphosphate		G	1.65	8	9	2
Cattaraugus	5981	F	1.66	7.49	9.25	2.20
Swift's Pure 12-2 Brand		G	——	12	——	2
Cuba	0213	F	——	11.68	12.14	2.05
SYRACUSE RENDERING CO., SYRACUSE, N. Y.						
Syracuse Animal Brand, A Complete Fertiliser for all Crops		G	2.46	8	9	3
Vernon	6795	F	2.41	7.63	8.81	3.26
Syracuse Ground Bone		G	2.46	——	23	——
North Collins	0925	F	4.14	——	21.75	——
Syracuse Gypsy Brand		G	——	12	13	2
Trumansburg	011	F	——	12.41	12.95	1.96
Syracuse Indian Brand for Corn and Wheat		G	1.64	8	9	2
Trumansburg	09	F	1.66	8.36	9.36	2.03
Syracuse Market Garden Manure		G	3.29	8	9	3
Williamson	6499	F	3.33	8.50	9.30	3.24
Syracuse Onondaga Brand		G	0.82	8	9	3
Brockport	6481	F	0.86	7.82	8.66	3.09
Syracuse Seneca Brand		G	1.24	8	9	3
Niagara Falls	0230	F	1.34	7.96	8.96	3.20
Syracuse Special for Celery, Cabbage and Potatoes		G	2.05	8	9	3
Bainbridge	6924	F	2.06	7.91	8.95	3.40

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
SYRACUSE RENDERING CO., SYRACUSE, N. Y. (*concluded*)						
Syracuse Superphosphate for Oats and Buckwheat		G*	0.82	7	8	2
Afton	6923	F*	0.92	6.78	7.86	2.16
THOMAS & SON CO., I. P., PHILADELPHIA, PA.						
Long Island Special		G	3.25	8	8.50	4
Southampton	0594	F	3.19	7.54	9	4.18
Nitrate of Soda		G	15	——	——	——
Southampton	0592	F	15.55	——	——	——
Northport Farmers Club 4-8-4 Fertilizer		G	3.29	8	8.50	4
Northport	6096	F	3.00	8.53	9.55	4.26
Northport Farmers Club 4-10-4 Fertilizer		G	3.29	10	10.50	4
Northport	6097	F	2.86	10.22	10.83	3.84
Northport Farmers Club 5-8-4 Fertilizer		G	4.11	8	8.50	4
Northport	6094	F	3.86	9.23	9.91	4
Northport Farmers Club 6-8-4 Fertilizer		G	4.90	8	8.50	4
Northport	6095	F	4.73	10.18	11.54	4.75
Potato Manure		G	3.25	10	10.50	4
St. James	6093	F	3.42	10.16	12.94	4.58
Pure Ground Bone		G	2.46	——	23	——
Northport	6099	F	2.55	——	24.05	——
Truck and Potato Manure		G	4.10	9	9.50	3
Aquebogue	0598	F	4.10	9.31	10.11	3.47
Truckers High Grade Fertilizer		G	3.25	9	9.50	3
Calverton	0577	F	3.33	8.82	10	3.40

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Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
Thomson & Son, Wm., Clovenfords, Scotland						
Genuine Scotch Soot		G*	——	——	——	——
New York	0378	F*	3.61	——	——	——
Thomson's Special Chrysanthemum Manure		G	4.25	7	10.50	1.50
New York	0369	F	4.22	8.80	11.30	3.63
Thomson's Vine, Plant and Vegetable Manure		G	3.25	8.50	11.50	2.50
New York	0368	F	3.92	9.11	12.87	5.21
Thorburn & Co., J. M., New York, N. Y.						
Thorburn's Complete Manure		G	2.47	8	9	3
New York	0351	F	2.49	8.37	9.87	3.16
Thorburn's Lawn Fertilizer		G	4.11	8	9	3
New York	0656	F	4.22	8.43	9.57	3.08
Tunnell & Co., Inc., F. W., Philadelphia, Pa.						
Acid Fish & Tankage		G	4.12	——	6	——
Riverhead	0554	F	3.75	——	6.75	——
Cauliflower Manure		G	4.12	8	9	4
Riverhead	0561	F	4.18	8.97	9.61	4
F. W. Tunnell & Co.'s Truck and Potato Manure		G	4.12	10	11	4
Hicksville	0683	F	3.59	8.07	9.49	4.23
General Manure		G	1	8	9	3
New Hampton	0528	F	1.28	8.84	9.44	2.21
Long Island Potato Manure		G	3.30	8	9	4
Riverhead	0553	F	3.11	8.53	9.21	3.57
Nitrate of Soda		G	14.81	——	——	——
Riverhead	0555	F	15.42	——	——	——
Sweet Potato Manure		G	1.64	7	8	2
Pine Island	0521	F	1.65	8.48	10.14	2.26

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
TUSCARORA FERTILIZER CO., BALTIMORE, MD.						
High Grade Dried Blood		G*	13.16	——	——	——
Dunkirk	0928	F*	12.67	——	——	——
Nitrate of Soda		G	14.81	——	——	——
Syracuse	6903	F	15.09	——	——	——
Tuscarora Acid Phosphate		G	——	16	16.50	——
Syracuse	6901	F	——	15.28	15.48	——
Tuscarora Acid Phosphate		G	——	14	14.50	——
Silver Creek	0909	F	——	15.32	15.52	——
Tuscarora Ammoniated Phosphate		G	0.82	7	7.50	1
Cincinnatus	030	F	0.76	7.12	7.56	1.54
Tuscarora Animal Bone		G	2.47	——	22	——
Silver Creek	0910	F	2.45	——	24.12	——
Tuscarora Big 4 No. 2		G	1.65	7	7.50	3
Cincinnatus	029	F	1.77	7.11	7.75	2.99
Tuscarora Crop Grower		G	0.82	8	8.50	2
Clifton Springs	0108	F	0.95	7.72	8.50	2.20
Tuscarora Fruit and Potato		G	1.65	8	8.50	10
Florida	0536	F	1.63	7.28	8.52	10.28
Tuscarora Phosphate and Potash		G	——	12	12.50	2
Manlius	021	F	——	12.02	12.14	1.84
Tuscarora Standard		G	1.65	8	8.50	2
Clifton Springs	0106	F	1.84	7.70	9	2
Tuscarora 1-9-3		G	0.82	9	9.50	3
Palmyra	0622	F	0.85	8.89	9.33	3.08
Tuscarora 2-9-3		G	1.65	9	9.50	3
Churchville	0630	F	1.67	8.87	9.31	3.10
Tuscarora 3-8-3		G	2.47	8	8.50	3
Syracuse	6904	F	2.22	7.68	9	3.26

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY SIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 10 FERTI	
			Nitrogen	Phospho Available
TUSCARORA FERTILIZER CO. BALTIMORE, MD. (*concluded*)				
Tuscarora 4-8-3		G*	3.29	8
Silver Creek	0913	F*	3.84	8.28
Tuscarora 5-8-3		G	4.11	8
Syracuse	6902	F	4.10	7.66
TUTHILL, NAT. S., PROMISED LAND, N. Y.				
Nitrate of Soda		G	15.17	——
Mattituck	6053	F	15.57	——
Southold Town Club Fertilizer		G	4.10	10
Mattituck	0562	F	3.98	9.80
TYGERT CO., J. E., PHILADELPHIA, PA.				
Tygert's Great Advancer Phosphate		G	4.11	9
Riverhead	6058	F	4.29	8.88
Tygert's Paramount Potato and Vegetable Manure		G	2.88	8
Cutchogue	6078	F	3.17	7.77
Tygert's Special Potato Fertilizer, Revised		G	3.29	8
Riverhead	6057	F	3.45	7.81
UNITED FERTILIZER CO., BUFFALO, N. Y.				
Evergreen Brand Flower and Lawn Fertilizer		G	8	14.50
Buffalo	6000	F	8.63	16.98
VAN IDERSTINE CO., THE, LONG ISLAND CITY, N. Y.				
Van Inderstine's Pure Ground Bone		G	2	——
Long Island City	0655	F	2.09	——
VAUGHAN'S SEED STORE, NEW YORK, N. Y.				
Vaughan's Bone Flour		G	——	——
New York	0373	F	3.79	——

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
VAUGHAN'S SEED STORE, NEW YORK, N. Y. (*concluded*)						
Vaughan's Lawn and Garden		G*	2.88	8	——	4
New York	0372	F*	2.80	8.19	10.09	4.16
Vaughan's Rose Grower Bone Meal		G	3.70	——	22	——
New York	0371	F	3.75	——	20.85	——
Vaughan's Sheep Manure		G	2	1	1.20	1
New York	0370	F	2.15	1.23	1.45	2.27
VIRGINIA CAROLINA CHEMICAL CO., NEW YORK, N. Y.						
Nitrate of Soda		G	14.82	——	——	——
Williamson	6495	F	15.02	——	——	——
V. C. C. Co's Ammoniated Potash Compound		G	0.82	8	9	2
Skaneateles	5898	F	0.96	8.13	8.97	2.43
V. C. C. Co's Beef Blood and Bone B. B. B. with 3% Potash		G	3.29	8	9	3
Phelps	6585	F	3.28	8.22	9.22	3.06
V. C. C. Co's Beef Blood and Bone B. B. B. with 4% Potash		G	3.29	8	9	4
Southampton	0593	F	3.31	8.24	8.72	4.63
V. C. C. Co's Bone Meal		G	2.47	——	22	——
Fredonia	0914	F	2.80	——	22.05	——
V. C. C. Co's Giant Alkaline Phosphate with 2% Potash		G	——	12	13	2
Springville	0258	F	——	13.09	13.81	2.04
V. C. C. Co's Good Luck Fertiliser		G	0.82	9	10	2
Springville	0256	F	0.83	9.90	10.50	2.34
V. C. C. Co's Good Luck Fertiliser		G	0.82	9	10	2
Bergen	0632	F	0.85	9.42	10.42	2.94
V. C. C. Co's High Grade Acid Phosphate		G	——	16	17	——
Branchport	0121	F	——	17.55	18.15	——

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZE
SIONER OF AGRICULTURE DURING

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number	
VIRGINIA CAROLINA CHEMICAL CO., NEW YORK N. Y. *(continued)*		
V. C. C. Co's High Grade Corn and Vegetable Compound with 3% Potash Webster	0609	G F
V. C. C. Co's High Grade Corn and Vegetable Compound with 4% Potash Eastport	6061	G F
V. C. C. Co's Little Giant Fertilizer with 2% Potash Freeport	0691	G F
V. C. C. Co's Owl Brand Potato and Truck Fertilizer with 3% Potash Skaneateles	5899	G F
V. C. C. Co's Plow Brand Fertilizer Springville	0254	G F
V. C. C. Co's Red Cross 14% Acid Phosphate Branchport	0119	G F
V. C. C. Co's Rescue Fertilizer Lockport	0220	G F
V. C. C. Co's Soluble Guano Skaneateles	5897	G F
V. C. C. Co's Special Corn and Grain Grower Phelps	6587	G F
V. C. C. Co's Star Brand Potato and Vegetable Compound with 3% Potash Lockport	0221	G F

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* These letters indicate, respectively, Guaranteed an

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
VIRGINIA CAROLINA CHEMICAL CO., NEW YORK, N. Y. (*concluded*)						
V. C. C. Co's Tip Top Potash Mixture		G*	—	16	17	2
Springville	0257	F*	—	17.36	17.90	2.58
V. C. C. Co's Tip Top Dresser with 3% Potash		G	5.76	5	6	3
Prattsburg	0410	F	5.42	6.24	7.12	3.10
V. C. C. Co's 20th Century Potato Manure with 3% Potash		G	4.12	8	9	3
Harford	6978	F	3.96	8.38	8.82	3.34
V. C. C. Co's Universal Fertilizer for all Crops		G	0.82	9	10	3
Palmyra	6485	F	1.04	9.71	10.38	3.08
V. C. C. Co's X X X Fish and Potash		G	1.65	8	9	2
East Northport	0801	F	1.88	8.46	9.32	2.24
WALLACE & CO., B. F., BROOKLYN, N. Y.						
Natural Humus		G	2.92	0.43	——	0.53
Brooklyn	0654	F	1.07	0.30	0.44	0.25
The Natural Humus Soil Builder		G	1.55	——	0.40	0.20
Rochester	0439	F	1.59	——	0.48	0.12
WEEBER & DON, NEW YORK, N. Y.						
Nitro Humus for Lawns and Plants		G	2.10	1.10	——	0.51
New York	6081	F	1.48	0.27	0.32	0.14
WHANN CO., W. E., PHILADELPHIA, PA.						
Whann's Chester Valley Special Potato Manure		G	3.29	8	9	4
New York	0667	F	3.37	8.44	9.96	4.10
WILCOX FERTILIZER CO., THE, MYSTIC, CONN.						
Pure Ground Bone		G	2.46	——	22	——
Greenport	0567	F	2.73	——	23.90	——

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* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
Wilcox Fertilizer Co., The, Mystic, Conn. (*concluded*)						
Wilcox Ammoniated Phosphate		G*	2.46	10	11	——
Orient	6079	F*	2.41	10.24	12.80	——
Wilcox Fish and Potash		G	2.40	5	6	3
Mattituck	0564	F	2.55	6.49	7.91	3.45
Wilcox Long Island Dry Ground Fish		G	8.24	4	6	——
Greenport	0568	F	8.82	6.04	7.10	——
Wilcox Potato Manure		G	2.05	6	7	3.50
Eastport	6062	F	2.06	7.25	9.60	3.68
Wilcox Potato, Onion and Vegetable Phosphate		G	3.30	8	9	3.50
Mattituck	0563	F	3.40	9.20	10.28	4.39
Wilk, John, New York, N. Y.						
Pulverized Sheep Manure		G	2.25	1	1.25	1.50
New York	6080	F	2.15	2.26	2.40	2.37
Witherbee, Sherman & Co., Port Henry, N. Y.						
Barium-Phosphate		G	——	——	14	——
Port Henry	0853	F	——	——	16.25	——
Woodruff & Sons, S. D., Orange, Conn.						
Woodruff's Home Mixture Fertilizer		G	4	8	——	4
New York	0651	F	3.38	8.71	9.73	5.55

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* These letters indicate, respectively, Guaranteed and Found

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1915 (*continued*)

Lime Compounds

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Calcium oxide	Magnesium oxide
No Name Given				
Ground Limestone		G*	———	———
Hemlock	0437	F*	48.60	3.40
American Agricultural Chemical Co., New York, N. Y.				
Fine Ground Nova Scotia Plaster		G	32.95	———
Whitney Point	060	F	38.72	0.43
American Hard Wall Plaster Co., Syracuse, N. Y.				
Ground Lime Stone		G	50	———
Kings Park	0805	F	52.96	3.80
American Lime & Stone Co., Tyrone, Pa.				
Hydra-Oxide of Lime		G	66.75	———
Canisteo	0434	F	68.22	3.07
Hydra-Oxide of Lime		G	———	———
Portville	0943	F	64.22	3.75
Baker Co., J. E., Bainbridge, Pa.				
Victor Ground Limestone		G	47	———
Nunda	6677	F	49.98	4.00
Ballard Co., J. W., Binghamton, N. Y.				
Agricultural Lime		G	———	———
New York	0525	F	36.16	28.35
Caledonia Chemical Co., Caledonia, N. Y.				
Better Farming Lime		G	50	———
Caledonia	6479	F	54.36	1.70
Wood Ashes Substitute		G	40	———
Caledonia	6478	F	42.76	1.23
Conley Lime & Fertilizer Co., F. E., Utica, N. Y.				
Raw Ground Lime		G	51.50	———
Oxford	6915	F	51.50	1.29
Corson, G. & W. H., Plymouth Meeting, Pa.				
Corson's Prepared Lime		G	42	———
New Hyde Park	0699	F	43.20	29.06

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*continued*)

LIME COMPOUNDS (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		Calcium oxide	Magnesium oxide
DUTCHESS COUNTY LIME CO., DOVER PLAINS, N. Y.				
Hydra-Oxide of Lime		G*	42	—
Dover Plains	4830	F*	49.14	29.99
EDISON PULVERIZED LIMESTONE CO., STEWARTSVILLE, N. J.				
Edison Pulverized Limestone		G	50	—
Homer	6200	F	49.06	2.31
FARNAM CHESHIRE LIME CO., FARNAM, MASS.				
Farnam Cheshire Lime Co's Agricultural Lime		G	60	—
Gardner	0531	F	60.36	0.79
HASEROT CANNERIES CO., THE, CLEVELAND, O.				
Horse Head Lime		G	54.72	—
Brocton	0246	F	52.98	1.82
INTERNATIONAL AGRICULTURAL CORPORATION, CALEDONIA MARL BRANCH, CALEDONIA, N. Y.				
Lime Carbonate		G	50	—
Caledonia	6480	F	56.32	1.77
KELLEY ISLAND LIME & TRANSPORT CO., CLEVELAND, O.				
Tiger Brand Hydrated Agricultural Lime		G	54	—
Cohocton	0149	F	54.74	21.41
LANGDON & CO., J., ELMIRA, N. Y.				
Ground Limestone		G	—	—
Alfred	0941	F	47.64	—
LE ROY LIME WORKS & STONE QUARRIES, LE ROY, N. Y.				
Le Roy Agricultural Ground Lump Lime		G	—	—
Earlville	6951	F	60.98	5.79
OHIO & WESTERN LIME CO., THE, HUNTINGTON, IND.				
Ground Quick Agricultural Lime		G	54.46	—
Andover	0942	F	54.04	36.16
PALMER, LOWELL M., YORK, PA.				
Challenge Brand Hydrated Lime		G	70	—
Hicksville	0682	F	71.22	2.22

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* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915 (*concluded*)

LIME COMPOUNDS (*concluded*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		Calcium oxide	Magnesium oxide
ROCK CUT STONE CO., SYRACUSE, N. Y.				
Ground Limestone		G*	———	———
Syracuse	6176	F*	38.84	———
ROCKLAND & ROCKPORT LIME CO., ROCKLAND, ME.				
R. R. Land Lime		G	60	———
Center Village	0398	F	62.60	13.77
SECURITY CEMENT AND LIME CO., HAGERSTOWN, MD.				
Berkeley Ground Lime		G	90	———
Sinclairville	0915	F	89.48	2.09
Berkeley Hydrated Lime		G	72	———
Springville	5989	F	73.04	2.69
Ground Limestone		G	44	———
Wallace	0401	F	49.24	3.64
SOLVAY PROCESS CO., THE, SYRACUSE, N. Y.				
Solvay Pulverized Limestone		G	50.40	———
Burdett	0426	F	48.34	3.18
WORLOCK STONE CO., CANASTOTA, N. Y.				
Raw Ground Diamond A Brand Lime		G	54.50	———
Cato	0425	F	52.48	1.84

CONTAINING LIME COMPOUNDS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		Total phosphoric acid	Potash	Calcium oxide
CONLEY LIME & FERTILIZER CO., F. E., UTICA, N. Y.					
Eureka		G*	8	5	40
Eaton	054	F*	8.65	5.53	42.52

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* These letters indicate, respectively, Guaranteed and Found.

APPENI

I. Popular Editions of Sta

II. Guide to Buildings and (

III. Periodicals Received by

IV. Meteorological Records.

POPULAR BULLETIN REPRINTS

PURITY OF FARM SEEDS IN 1914.*

F. H. HALL.

Gradual improvement.

In 1912 more than one-fifth of the sample
cultural seeds inspected in New York Stat
violation of the law; in 1913, less than one-s
condemned; and in 1914 the proportion had
to a little over one-tenth. This indicates considerable imp
in seed-trade conditions generally, though a change in the
the "count" method of determining the percentage of im
the "weight" method is responsible for some of the
between 1913 and 1914, but probably for only a small pa
gain. Seeds were undoubtedly purer, as a general rule,
than in 1913; yet in some instances full advantage was ta
weak point in the law, to market seeds that could not be s
in some adjoining states.

Law not a sure protection.

The law does not require guaranty of a cer
centage of good seeds, but that the goods s
not contain more than a certain proportio
ct. by weight) of "foul or foreign seeds," un
fact be plainly stated. This allows the unscrupulous dealer t
as much sand, and other rubbish not seeds, as he thinks th
will overlook, and also to include an indefinite quantity of o
seeds of the same kind as the sample; for these impurities
"foul or foreign seeds." Neither does the law demand free
even comparative freedom, from weed seeds, even those of o
troublesome or dangerous pests.

In consequence of these unfortunate deficiencies in the
samples of the 303 examined were found by Station analyst
composed mainly of brown, dead and shriveled seeds, 6 wer
infested with dodder, 2 contained bull thistle seeds, 2
thistle seeds, 5 considerable mustard seed and 125 varying a
of seeds of other weeds classed as noxious. Of these impurit
quality or quantity was such that 57 of the seed samples we
sidered of questionable value for seeding, 26 objectionable

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* A reprint of Popular Edition of Bulletin 394, January, 1915; for complet
see p. 690.

absolutely worthless. Twenty-three of the samples contained considerable amounts of chaff, and 10 were very dirty, being uncleaned seed. Only a trifle over one-third of the samples were classified as " good " in quality, the others not referred to above being regarded as only average in grade.

Surprisingly, the great majority of the 33 violations of the law were really much better seeds, from the farmer's standpoint, than many of those that had to be passed. These violations were due to finding in alsike clover seed samples more than 3 per ct. of white clover and timothy seeds — foreign seeds present through growth of the other two forage crops in the fields of alsike. The three kinds of seed are so similar in size, shape and weight that their separation is practically impossible.

Several of the alfalfa samples were evidently of commercial Turkestan alfalfa, showing by their gray or whitish color the coating of very fine clay which characterizes seeds from that region. This commercial Turkestan alfalfa is not as desirable as American-grown strains of this plant.

Much of this commercial Turkestan alfalfa seed is now stored in America; and this old seed — somewhat inferior even when fresh — will undoubtedly be placed on the market during the coming season to meet the demand, since the war has stopped the importation of fresh supplies.

Dodder-infested alfalfa-seed will also be forced on the market without doubt; and half the samples of alfalfa seed being received at date of this writing (February 20, 1915) show presence of this very undesirable pest.

The law requires no notice of the presence of such impurities unless they exceed three per ct.; and even one-half of one per ct. of dodder might so infest an alfalfa field as to make it valueless.

The purchaser of seeds must, therefore, either rely upon his own judgment as to the presence of seeds of harmful weeds or must have a purity test made.

Voluntary purity tests. In addition to the 303 official samples, the Station also examined during 1914 nearly four times as many samples, 1,155, sent in by correspondents, and reported on their purity. Here, as in the official samples, the marketing of Turkestan alfalfa seed in considerable quantity was indicated; as one-sixth of the samples contained seeds of Russian knapweed, and others showed by the gray color of the alfalfa seeds that they had grown on the dusty plains of Turkestan. Dodder seed was less common in 1914 samples than in those of 1913, but as indicated above, there is great danger that dodder-infested seed will again be common in 1915.

The examinations of 1914 did not bring to light the seeds of any especially noteworthy new weeds; but added considerably to the number of less importance that are coming into the State through crop seeds. In the samples examined in 1913 and 1914, seeds of 155 weeds or noxious plants were found while 15 kinds of crop seeds were present in samples where they were classed as foreign seeds. In the complete edition of which this is a " popular edition " a table gives a list of these impurities, with the number of times they were found in each kind of crop seed examined.

Sampling and sending seeds.

These purity examinations of samples sent in by individuals seem so helpful, and so necessary as a supplement to the official determinations, that the station will continue, until the demands overtax its facilities, to make examinations of samples for farmers who wish to sow only pure seed. Certain conditions are essential, however, if the samples are to furnish reliable information.

First, the sample must be large enough to represent fairly the quantity of seed from which it is taken. This means at least two ounces for the larger seeds, like alfalfa, the clovers, millet and rape. and at least one ounce for grass seeds.

Second, the sample should be taken from lots from which the dealer agrees to supply the purchaser's needs after the report of the analysis has been received. The small packets or samples sometimes furnished by dealers are frequently taken from seed specially cleaned for advertising purposes; and examination of them serves to delude rather than to enlighten the sender.

Third, in taking samples, the bulk of seed should be thoroughly mixed, or small quantities should be taken from top, middle and bottom of the bag or other container and mixed before taking out the amount to be sent to the Station.

Fourth, the sample should be sealed in a strong, tight package that will not be easily broken in the mail; and marked plainly with the name and address of the sender. It is not sufficient to send an unmarked package with a separate letter describing its contents, as the Station may receive a score of seed samples in a single mail.

If these conditions are complied with, the Station will examine the samples as promptly as possible, usually within two days, and report to the sender at once, giving the percentage of pure seed, percentage of rubbish and percentage of other seeds, with an indication of the kind and quantity of specially undesirable weed seeds present. A statement is also usually made as to the general quality of the seed; but the Station does not make germination tests. It must be thoroughly understood that these examinations will be made for farmers only, or for other intending purchasers of seed for farm use. The Station can not and will not knowingly examine seeds for dealers or others who wish to know their quality for purposes of sale, or for labeling under the law.

PRUNING WOUNDS NEED NO PROTECTION.*

F. H. HALL.

Uncovered pruning wounds heal quickest.

Rarely do experiments in agriculture disprove commonly accepted beliefs; but this has been the result from a four-year investigation at this Station on the effect of various protective materials on the wounds of fruit trees due to pruning. Though many materials were used in the test none was found to be of benefit; for in every case untreated wounds made as good recovery as those covered. In nearly all instances the supposedly helpful covering injured the exposed tissues and retarded healing; the mechanical exclusion of the germs of plant diseases by impervious coverings and the destruction of these germs by preservatives and disinfectants proved without value; while wounds kept from drying out by some protective material healed no more rapidly than those left open to the air.

Some coverings injurious.

Paints made from white lead, white zinc and yellow ochre were used in the test, as well as coal tar and avenarius carbolineum which are preservatives and disinfectants, and shellac which forms an impervious coating over the wounds. In different tests extending over four years these materials were applied, both immediately following pruning and after a delay of six weeks to allow some drying of the surface, to considerable numbers of large and small wounds of young and old apple trees pruned in the winter and in the spring; and the action of the same materials on the smaller wounds of winter-pruned peach trees was under observation for three years.

In no case was there benefit from the use of any of the coverings. On peach all were so harmful that it may be safely said no covering should ever be used on trees of this, or, presumably, of any stone fruit. The injury from shellac was only slight. On the apple the avenarius carbolineum was very harmful, the yellow ochre paint retarded healing noticeably and destroyed some tissue, the white lead and white zinc were less injurious and the shellac did little or no harm but no good.

Conclusion.

The series of careful, long continued comparisons and observations indicates unmistakably that pruning wounds on peaches and other stone fruits should never be treated with so-called "protective" covering materials, since their use is decidedly harmful. On the apple and other pome fruits there can be no gain from treating small wounds at least, with considerable liability to harm. On very large wounds which heal only after several years or not at all, it is possible that some protection of the wound may be useful by keeping out disease germs, but of this the experiments give no proof.

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*A reprint of Popular Edition of Bulletin No. 396, February, 1915; for complete edition see p. 506.

LIME-SULPHUR INJURIOUS TO POTATOE

F. H. HALL.

Conditions prevent desired test.

For four years the Station has failed to proof that lime-sulphur will or will not p potato diseases. In three seasons practical blight appeared on the test fields, and in the l year it appeared so late that many of the sulphur sprayed plants were already dead fro effects of the spray mixture.

Lime-sulphur not a good remedy.

To know the effect of lime-sulphur on the di is very desirable, and the experiments will be tinued with that object in view; but we have le already that this material is not to be recomm for use on potatoes because of its harmful effe the plants themselves. In 1911, as recorded in Bulletin No. lime-sulphur dwarfed the potato plants and reduced the yie bushels to the acre below that on check rows not sprayed; a 1912 (Bulletin No. 352) it dwarfed the plants so that they very early and produced 111½ bushels less marketable potato the acre than those on bordeaux-sprayed rows.

In tests reported in the present bulletin no late blight app in either 1913 or 1914, but lime-sulphur aggravated the effe tipburn, dwarfed the plants, shortened the period of growth reduced the yield each season. In 1913 early frost killed the pl on much of the experimental area when the bordeaux-spr rows were still growing luxuriantly though many of the lime-sul sprayed plants had been dead from two to three weeks. This lessened the contrast between the treatments, but the lime-sul rows produced about 25 bushels less to the acre than the check r while those sprayed with bordeaux gave almost 20 bushels more t the checks. In 1914, bordeaux spraying increased the yield bushels to the acre and lime-sulphur spraying decreased it 16 bus Of six reports from other investigators, only one, based on a si small test, gives as great an increase from the lime-sulphur as f bordeaux mixture, while five show unfavorable results from the of lime-sulphur similar to those in our tests.

Lime-sulphur is not a good spray mixture for potatoes.

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* A reprint of Popular Edition of Bulletin No. 397, February, 1915; for comp edition see p. 291.

DO LOW SCORES ALWAYS MEAN POOR MILK? *

F. H. HALL.

Milk quality more than composition.

Good milk is one of the best and usually one of the cheapest of man's foods. It may become, on the other hand, more easily than almost any other, a most unsatisfactory article of diet and a menace to health. Knowledge of these facts has brought forward many laws and regulations to prevent the sale of adulterated milk or of milk that is unsanitary. To detect adulteration certain physical and chemical tests have been found very effective; but we are poorly supplied with accurate workable guides to quality — simple, rapid tests or examinations that will tell us quickly whether milk is dirty, is liable to develop unpleasant tastes or odors, or whether it contains disease germs that may produce severe or fatal illness.

Score cards do not show quality of milk.

Students of dairying found, years ago, that some of these undesirable contaminations of milk are influenced more or less directly by stable conditions, by the care of the herd in and out of the stalls, and by the methods of handling the milk on its way from the cow to the customer. But neither then nor since have sufficiently comprehensive, accurate studies been made to prove definitely how much conditions or methods change milk quality.

To serve as a guide in comparison of dairies and dairy methods, to present in concrete form the conditions in the ideal dairy, and to indicate readily what changes should be made in poorly designed stables and in unsatisfactory methods of milk handling, teachers of dairying and others interested devised score cards which gave to each of many conditions or factors a numerical value. These values were largely arbitrary and varied according to the judgment of the card-maker as to the importance of the factor in producing clean milk. Needless to say, the various cards now in use differ greatly.

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* A reprint of Popular Edition of Bulletin No. 398, March, 1915; for complete edition see p. 125.

New use for score cards. As a convenience in making comparisons, either in the same dairy at different times, or between different dairies, the cards proved very useful and they soon became known to all students of dairying and dairy inspectors. Their common use as a guide in checking up conditions gradually led to a belief that the cards really measure the effect of these conditions on the milk — a function not at all in the minds of those who first designed the system of scoring. But with the increasing demand for pure market milk and with the absence of ready, reliable measures of milk quality, the cards acquire the reputation of indexes to quality; and in some cases, indeed, they have been officially adopted as the one means of distinguishing between good milk and poor milk. That is, in some markets, the product of any diary that does not score above a certain mark on a certain card is excluded from sale or given a low grade.

Is this use of dairy score cards justified? Investigations made at this Station prove that it is not.

Cards disagree. In the first place, the cards now in common use in this State do not agree, either in the number of factors to be considered or the relative weight they give to those used. In consequence, the use of different cards, simultaneously, in scoring a series of dairies results in very dissimilar ranking of the milk produced by the various herds; and some cards might exclude from market, milk well above the limit by the scoring of other cards.

This was shown very plainly when thirty-four dairies furnishing milk to a small city were scored by one of the Station bacteriologists, using three different cards for each dairy. These cards were: (1) that adopted by the Health Department of New York City; (2) the "Official" card used by the Dairy Division of the U. S. Department of Agriculture, endorsed by the Official Dairy Instructors' Association and adopted with slight modification by the New York State Board of Health; and (3) the card used by the Dairy Department of the New York State College of Agriculture, known as the Cornell card.

Before making these scorings the investigator familiarized himself thoroughly with the method of use of each of the cards, by scoring many dairies by each system when accompanied by one who was accustomed to the use of the particular card.

The results are best conveyed in the form of a diagram (pages 6 and 7) which shows the rank of each dairy on the three cards. The horizontal lines in this graph represent the average minimum score for each grade of milk established by the regulations of the New York State and New York City Boards of Health.

It is evident from this graph that the Cornell card is the most lenient. This is shown by the fact that of the 34 dairies, the total scores of 29 were high enough to entitle them to produce Grade A or

Grade B milk, while according to the scores on the Official card only 16 dairies were entitled to this privilege, and only 5 according to the scores on the New York City card. The Cornell card rates only 5 dairies as Grade C, while 18 are thus rated on the Official card and 14 on the New York City card. None of the dairies scored below the exclusion point on either the Cornell or the Official card, while 15 dairies scored below this point on the New York City card.

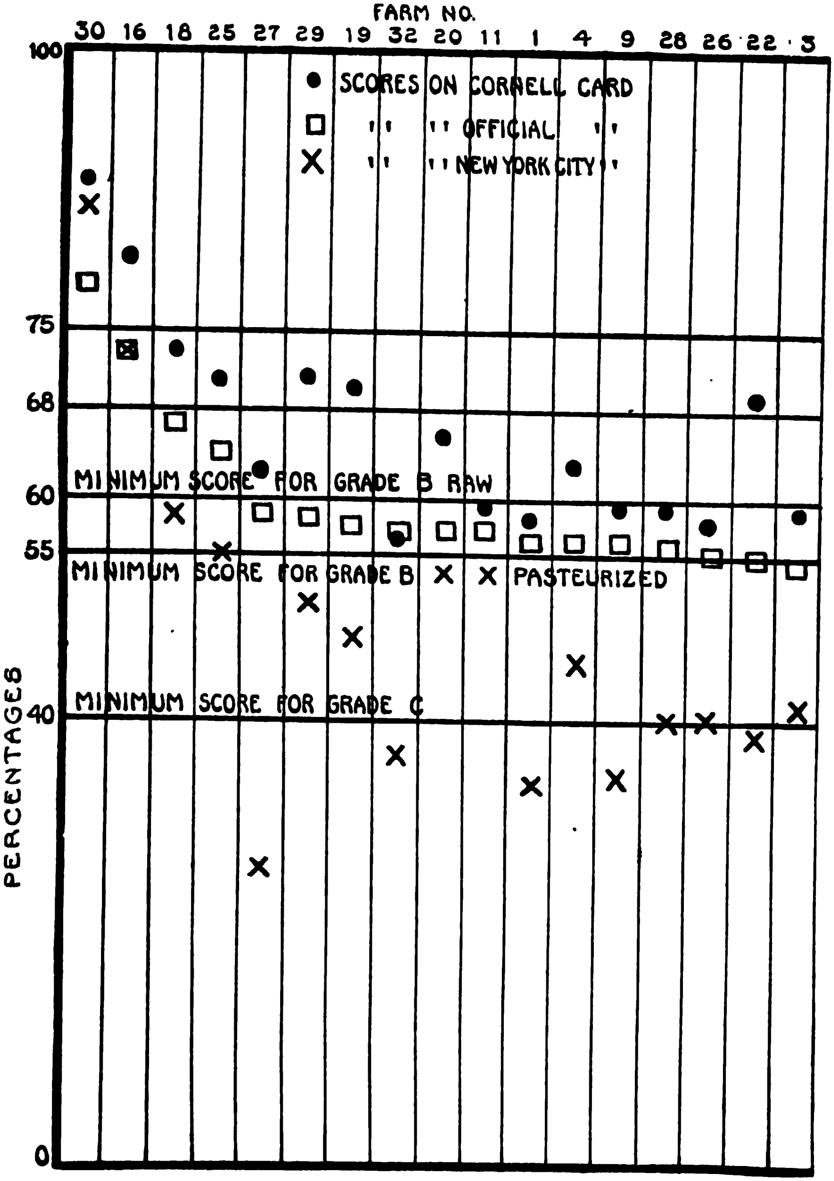
It is further evident that there is little agreement between the scores obtained by the three cards when applied to the same conditions. In this investigation, however, there was an agreement among the three cards as to the three dairies which would be considered the best from the standpoint of scores. These dairies occupied the same relative position on each card. Beyond this there were instances of wide variations. The scores obtained by the Official card and the Cornell card agreed as to the poorest scoring dairy. while there was a slight variation in the rating of this particular dairy on the New York City card. As will be seen from the graph, however, the variations between the scores on the Official card and the Cornell card are not so great as between the New York City card and either of the other two. The greatest variation found is in the case of Farm 27 which scores at the foot of the list on the New York City card but scores 32 points higher on the Official card, rating fifth from the top, while the score on the Cornell card is 5.4 points higher than that of the Official card and is 37.4 points higher than the New York City card, and rates thirteenth from the top.

It should be kept in mind that these comparative scores are discussed in this paper with reference to the interpretation gained by the investigator while working with inspectors trained in the application of the respective cards. Since different interpretations exist, it is quite probable that other systems of cuts than those used would give somewhat different results. It may be that both the New York City and Official cards could be so interpreted that the results secured would compare closely. This tendency to vary the interpretations put upon the cards is one of the weaknesses of all of the present score cards as a means of grading milk, which has been generally recognized.

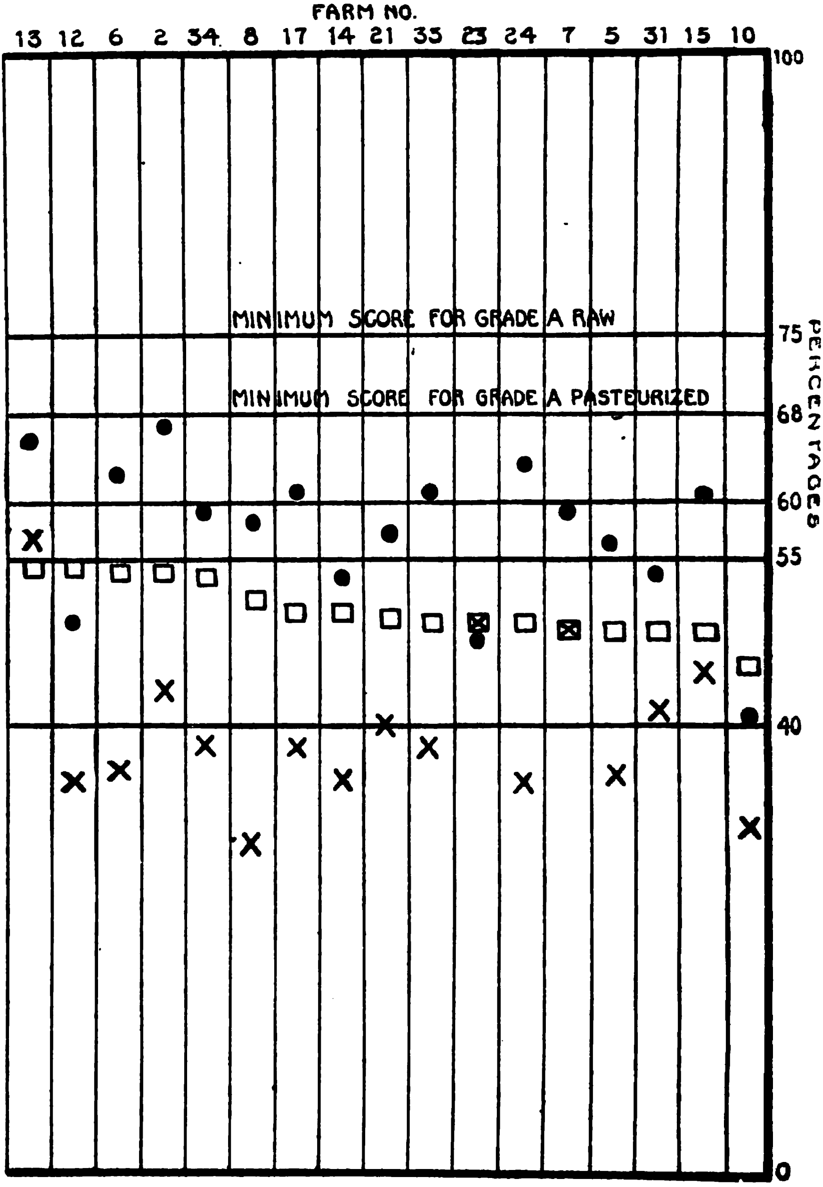
Scores and quality.

These disagreements are sufficient to cast considerable doubt on the reliability of score cards as indexes to milk quality; but the "breakdown" test comes when the ratings given by the cards are compared with the quality of the milk as far as this is indicated by bacteriological counts.

Accompanying the scoring of these dairies, samples of the milk produced in each were taken daily, for varying lengths of time, at least one week, usually of both night and morning milk, as delivered at the distributing stations of the two companies that supply most of the milk used in the city.



Graph I.—Comparative Scores of Thirty-four



DAIRIES BY THREE SCORE-CARD SYSTEMS OF RATING.

The difficulties which beset an investigation which attempts to compare the actual quality of milk with barn scores are at once apparent. In the first place, the actual quality of milk is difficult to determine by means of present laboratory methods. There is no way of accurately measuring such factors as odors, tastes and dirt in milk, nor (from the standpoint of routine analysis) is there any practical means of detecting the presence of disease organisms. In the second place, the chemical constituents of the milk are not mentioned on dairy score cards. This leaves only one means by which the quality of milk and the dairy score may be compared, namely, the bacteria count.

The samples were taken with every necessary care to make them representative of the milk from which they came, were placed in sterile bottles, sealed, and taken quickly to the Station bacteriological laboratory where culture plates were made from each and the colonies of bacteria counted in accordance with the generally accepted method. This " bacteria count " does not give the actual number of bacteria in the milk; but an approximate figure as fair for one sample as for another.

The disagreements between the ranking of the different dairies by the score card system and by this bacterial test of quality are many and extreme. In the graph given on pages 6 and 7 the numbers at the head of the columns give the order of the dairies on the basis of the bacteria count of the evening milk, of which samples were always taken, and which gives a better index to the condition of the milk when it reaches the consumer than would samples of the morning milk alone.

Milk from the first dairy gave an average bacteria count of less than 10,000 per cubic centimeter, placing it with highest grade milk so far as the bacteria count is concerned; but this milk would have been *denied entrance* to the New York City market, since the rating of the dairy on the score card placed it below the minimum for Grade C milk. Its rating on the other cards was better, yet only good enough to allow the milk to be sold as Grade B pasteurized; Dairy 2 was scored just high enough on the City card to allow sale of the milk as Grade C and only a little better on the other cards; yet the " bacteria count " was only 55,000. In score on each of the cards this dairy was only about 5 per ct. above Dairy 34, of which the count indicated one thousand times as much bacterial contamination. Only two of the 34 dairies would have satisfied the requirements as to total score for selling Grade A milk and only three others those for Grade B milk, while nearly half of the dairies would have been forbidden to sell milk in New York City in any form; yet the " bacteria count " indicates that the milk from Dairies 1 and 2 was Grade A raw and that from Dairies 3 to 8 Grade A pasteurized.

These figures show startling illustrations of the exclusion of good milk by score card rating; and equally marked examples can be given of the acceptance, by dairy scoring, of very poor milk, bacteriologically considered.

TABLE I.— A COMPARISON BETWEEN THE BACTERIA COUNT OF NIGHT MILK AND THE DAIRY SCORES OF THIRTY-FOUR FARMS.

Farm number.	Plate count per c. c.		New York City score.		Official score.		Cornell score.
	P. M. milk.	A. M. milk.	Total.	Methods.	Total.	Methods.	Total.
1	7,580	13,000	34	20	56.90	36.35	430 M*
2	54,000	57,000	43	28	53.65	36.50	446 M
3	98,000	....	41	25	54.90	35.20	432 M
4	102,000	29,000	45	25	56.60	33.90	439 M
5	118,000	52,000	36	21	49.00	28.45	428 M
6	138,000	21,000	36	22	53.85	33.85	437 M
7	148,000	34,000	49	26	49.45	29.15	433 M
8	162,000	18,000	28	15	51.35	31.55	430 M
9	267,000	99,000	35	21	56.30	34.40	433 M
10	300,000	....	31	19	45.95	29.10	401 M
11	313,000	....	53	24	57.20	36.35	432 M
12	380,000	....	39	22	54.15	31.75	416 M
13	537,000	907,000	57	30	55.70	31.90	442 M
14	538,000	165,000	35	18	50.10	32.15	422 M
15	570,000	610,000	45	22	48.70	29.05	435 M
16	687,000	58,000	73	41	73.08	38.63	469 G
17	732,000	....	38	20	50.45	29.25	436 M
18	762,000	320,000	58	29	66.10	37.20	455 G
19	777,000	13,000	47	29	58.65	34.10	450 G
20	812,000	67,000	53	29	57.35	34.40	442 M
21	937,000	153,000	40	22	50.05	28.65	429 M
22	1,442,000	....	50	29	49.75	27.75	413 M
23	1,758,000	45,000	39	23	54.95	32.05	447 M
24	1,758,000	103,000	35	23	49.65	32.15	439 M
25	2,700,000	....	55	24	64.25	30.60	451 G
26	2,999,000	1,282,000	40	20	55.40	31.65	430 M
27	3,056,000	....	27	14	59.00	37.45	439 M
28	3,158 000	88,000	40	27	55.90	31.15	433 M
29	3,167,000	....	50	30	58.75	29.70	451 G
30	4,180,000	....	86	50	79.40	43.35	481 E
31	4,215,000	....	42	18	48.95	28.10	417 M
32	5,239,000	163,000	36	22	57.80	39.00	428 M
33	13,356,000	3,219,000	38	23	49.85	30.20	436 M
34	57,820,000	1,284,000	38	25	53.60	29.80	433 M

* E = Excellent, G = Good, M = Medium.

The dairy scored highest on all three cards, entitling the owner by a large margin, to sell Grade A milk, raw, was among the poorest, bacteriologically (No. 30), with a count of over 4,000,000; and the one scored second was only No. 16 by bacteria count. Of the ten dairies with the best score card records, eight were in the poor half of the list by the bacterial test of care and cleanliness. Only one dairy, No. 11, was given the same rank by the cards as by the number of bacteria found.

Conclusion

In so far as the quality of milk can be determined by present laboratory methods, there exists no relationship between the quality of milk and the dairy score on the score cards now in use. Milk of all grades, ranging from the finest quality to the poorest, is produced in barns which would be excluded on account of low scores. All grades of milk are likewise produced in the high-scoring barns.

The real explanation for this lack of relationship between the scores and the bacteria counts cannot be given as yet with absolute certainty. The most apparent reason, as shown by investigations made at this Station, is that a large number of the items included on the score card have little or no effect upon the number of bacteria present in the milk. In other words, too great emphasis is placed upon unessential factors in all of the score cards studied, with a consequent lessened emphasis upon the factors which actually do affect the milk.

Some may contend that these findings encourage the production of milk under filthy conditions. This contention will be raised only by those who hold the idea that low-scoring dairies are necessarily unsanitary and filthy. Such conditions have, however, not been found to hold true in the region studied; because low-scoring dairies were found which vied in cleanliness with the most ideal of the high-scoring dairies. On the contrary, however, these facts give decided encouragement to the intelligent dairyman who finds that he can produce high-grade milk by the simple observation of the few essential factors of cleanliness and care. This places him in a position to secure a greater profit from his business while at the same time he has the moral satisfaction of knowing that he is selling a high-grade article. Where the present score cards are used, all dairies, in order to get credit for Grade A milk, are forced to an additional expense and consequently to an increased cost of production. At the same time a compliance with the score-card requirements carries with it no guarantee that the quality of milk will be improved or rendered more safe from the standpoint of public health.

The fact that high-grade milk can be produced with simple equipment likewise gives encouragement to the consumer who is as much interested in keeping down the cost of producing high-grade milk as is the producer.

None of the results secured in this investigation can be so construed as to disprove the value of dairy score cards, but they do show that present score cards cannot be satisfactorily used as a means of grading milk according to quality. There is little hope of designing a score card which will accomplish this purpose until all of the factors which are thought to affect the quality of milk in any way have been carefully studied; and the influence of each determined and accurately measured. In this way the really important factors can be singled out and given the proper values on the score card.

"SPINDLING-SPROUT" OF POTATOES.*

F. H. HALL.

Dry, hot weather weakens potatoes.

Potatoes produce best in moist, cool climates, as in their original home on the plateaus of the Andes. They seem to " run out " quite rapidly in sections with much hot, dry weather during their maturing period; and it is usually considered necessary in such sections to renew the stock, sometimes annually, sometimes biennially, by using seed grown farther north where climatic conditions are more favorable. This is quite commonly done on Long Island; and experiences there during 1914, following the hot, dry summer of 1913, emphasize the necessity for the practice. Ordinarily, specific symptoms of deterioration extend only to reduction in yield; but in 1914 a marked change in the character of the plants was so common as to attract general notice.

Spindling-sprout disease.

In almost every field planted with home-grown seed on Long Island in 1914 there were many missing hills and the plants varied greatly in size. Investigation, particularly in one field near Riverhead, showed that the trouble approaches a disease in character, tracing back directly to the tubers. The affected tubers could be easily selected among those left in the lot used for seed as about one-third of the whole number bore exceedingly slender sprouts like those observed on affected plants in the field; while the remainder bore the sturdy, robust sprouts characteristic of the variety, Green Mountain. There was little difficulty in separating the tubers, for nearly all were plainly sound and vigorous or plainly affected with " spindling-sprout," with very few showing any intermediate degree; and all the sprouts on each tuber were of the same character, either stocky or slender.

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* A reprint of Popular Edition of Bulletin No. 399, March, 1915; for complete edition see p. 302.

Field test. About forty of these tubers were planted at Geneva for observation; and all those with slender sprouts produced weak, spindling plants and yielded only small tubers, averaging half a pound to the hill; while the tubers with stocky sprouts gave healthy plants and yielded nearly one and one-half pounds to the hill.

The field at Riverhead improved considerably as the season advanced and by the middle of June showed 95 per ct. of a full stand, of which, however, nearly 30 per ct. of the plants were distinctly smaller than usual. In another case, where many tubers of the variety Norcross were seen to be producing small sprouts before planting, the owner's field and an experimental patch planted for the Station showed nearly 50 per ct. of small plants.

Not a new trouble. Examination of bulletins and periodicals showed that this trouble is not a new or uncommon one; as the same or very similar symptoms are reported for potatoes in other States and in Europe. In a few of the cases described, however, the trouble, though similar, is probably not identical with spindling sprout. Various causes are suggested for the condition, but growth of the seed tubers in hot, dry weather is most commonly given, and is probably the true explanation.

Remedy. As the effect of this trouble is a serious lessening of the yield, every effort should be made to avoid tubers affected by it. Although occasional instances of spindling-sprout are reported from Maine and even from Canada, northern-grown tubers are generally free from the affection, and should be used when the location, in the South, or hot, dry weather during the previous season seem liable to produce deterioration of the seed. Whether " spindling-sprout " is liable to occur can usually be told with considerable certainty by a sprouting test. From four to eight weeks before planting time a small quantity of the potatoes should be put in a warm, dark place to sprout. If all of the tubers produce strong sprouts it is safe to assume that the seed is suitable for planting; but if some of the tubers produce spindling sprouts, the seed is not fit to plant. It seems as if this should be a simple method of avoiding trouble with spindling-sprout.

GROUND LIMESTONE FOR SOUR SOILS.*

F. H. HALL.

WHY USE THIS FORM OF LIME?

Liming needed.

Many New York soils need lime. On probably three-fourths of the cultivated area of the State, the lime content has become so much reduced that legumes, the better grasses, beets and many other crops fail or give poor yields where once they may have grown well, because the soil has become acid or because the crops no longer find the lime they actually require as plant food.

Success with these crops is fundamental to profitable agriculture; and if, by moderate expense, the soils outside the limestone belt can be made to produce good yields of these better crops, the level of the agriculture of the entire State will be notably raised.

Liming inexpensive.

Ground limestone can now be obtained very readily and very cheaply. New quarries have been opened in many places (see pages 4 and 5), dozens of grinding plants have been put in operation, the equipment has been simplified and improved, the output of limestone of excellent quality is very great, and the costs of production and distribution have been greatly reduced. Limestone ground fine enough for general use now costs only $1.25 to $3.00 a ton at the railroad stations of most farmers in the State.

Ground limestone efficient.

Ground limestone has been thoroughly proved an efficient and economical aid to crop production by long continued experiments in Ohio, Illinois, Pennsylvania, New Jersey, Rhode Island and many other States; and data are rapidly accumulating to show the same favorable results in this State.

Already this form of lime has shown itself effective in aiding the establishment of alfalfa on the poor hill lands of southern New York, as useful as much more expensive forms.

In Ohio, in twelve years of testing on many plats, moderate applications of limestone once in a crop rotation of five years, on soils only moderately acid, have given average net profits of $15 an acre when used alone, and of from $2 to $5 more than this when used with phosphorus, with barnyard manure, with phosphorus and potassium, or with complete commercial fertilizers.

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* A reprint of Popular Edition of Bulletin No. 400, March, 1915; for complete edition see p. 53.

In New Jersey, the value of the increase in general farm crops in five years after a two-ton application of ground limestone was placed at $25 an acre, and the value of the increase in vegetables at $48.

Limestone and quicklime.

Ground limestone is as efficient as burned lime, if ground moderately fine and used in quantity to give the same amount of calcium and magnesium per acre. Nine years of comparative trials at the Ohio Station, four at the Tennessee Station, eleven years at the Maryland Station and much other evidence both from this country and from abroad prove that the limestone gives at least as good and sometimes better results than its lime equivalent in other forms. Quicklime occasionally appears to injure land or crops through its caustic properties; but ground limestone, being chemically neutral, can never harm either soil or crop. It should be said here, though, that, like most other forms of lime, the ground stone may increase the virulence of potato scab.

Limestone convenient to use.

Ground limestone is more convenient to handle than other forms of lime. When ground fine enough for farm use — so all the material from the grinder passes a 10-mesh sieve — the stone can be shipped and handled in bulk, without the expense for bagging necessary when finely ground freshly-burned lime, hydrated (slaked) lime or air-slaked lime is used. The ground limestone can be easily distributed, either by hand or by a lime-sower, without the unpleasant effects on skin and eyes that follow the handling of caustic lime.

Low cost offsets smaller lime content.

The decidedly lower cost of ground limestone than of other forms of lime more than counterbalances its lower lime content. Undoubtedly freshly burned lime from a pure stone contains the essential soil-sweetening compounds, calcium and magnesium oxide, in most concentrated form. This is an advantage that must be considered when freight haul or wagon carry are very long; but usually the price for the ground stone, with its 800 pounds or so to the ton of inert carbon dioxide, is so decidedly less than that of other forms of lime that it is far more economical to use although freight and haulage expenses have to be paid on some useless material. When made from impure stone, any advantage for the burned lime is lessened, since the percentage of impurity is increased by the burning.

In the soil the quicklime very soon absorbs carbon dioxide to replace that driven off by heat and becomes again chemically and practically the same as ground limestone from the same source.

Composition of Ground Limestone for Sale in New York State.

Name of company.	P. O. address.	Location of quarry.	Calcium carbonate.	Magnesium carbonate.	Total carbonates.	Calcium carbonate equivalent.	Geological formation.
Adams & Duford Co	Chaumont	Chaumont	92.9	.7	93.6	93.8	Lowville limestone.
B. & B. Lime & Stone Co.	Mellenville	Mellenville	70.3	7.7	78.0	79.4	Manlius limestone.
Buffalo Cement Co	Buffalo	Buffalo	52.0	39.0	91.0	98.3	Cobleskill dolomite limestone.
Beardsley, W. S., & Co	Auburn	Auburn	84.5	2.9	87.3	88.0	Onondaga limestone.
Burkdorf, H. J	St. Johnsville	St. Johnsville	89.4	3.0	92.4	92.9	Trenton limestone.
[1] Caledonia Chemical Co	Caledonia	Caledonia	85.0	1.6	86.6	86.9	Marl.
Callanan Road Imp. Co	South Bethlehem	South Bethlehem	75.2	6.3	81.5	82.7	Manlius limestone.
Canajoharie Stone Co	Canajoharie	Canajoharie	78.8	6.6	85.4	86.7	Glens Falls limestone.
Chazy Marble Lime Co	Chazy	Chazy	91.1	2.2	93.3	93.7	Valcour limestone.
Conley Stone Co	Utica	Munnsville	94.1	.3	94.4	94.5	Manlius limestone.
Conley Stone Co	Utica	Blakeslee	91.0	1.8	92.8	93.2	Manlius limestone.
Dutchess Co. Lime Co	Dover Plains	Dover Plains	53.8	34.0	87.8	94.1	Stockbridge limestone.
DeVoe Limestone Co	Accord	Accord	68.3	10.3	78.6	80.5	Decker's Ferry limestone.

Frets, M. W.	Richfield Springs	Richfield Springs	89.7	.4	90.1	90.1	Onondaga limestone.
Geneva Limestone Co.	Geneva	Oaks Corners	59.7	28.4	88.1	[2]93.4	Cobleskill limestone.
Harris, John	Saratoga Springs	Rollins Hollow	88.1	3.0	91.1	[3]91.7	Glens Falls limestone.
Langdon & Co.	Elmira	Pekin	84.8	6.6	91.4	92.6	Wolcott limestone.
LeRoy Limestone Co.	LeRoy	LeRoy	89.1	1.7	90.8	91.2	Onondaga limestone.
Medina Limestone Co.	Medina	Medina	53.7	43.3	97.0	105.1	Lockport dolomite limestone.
Norton Stone & Lime Co.	Cobleskill	Cobleskill	75.9	2.2	78.1	78.5	Coeymans limestone.
Otsego & Herkimer R. R. Co.	Cooperstown	Cullen	88.9	1.5	90.4	90.7	Onondaga limestone.
Rock Cut Stone Co.	Syracuse	Rock Cut	70.3	15.0	85.3	88.1	Manlius limestone.
Roberts, George H.	17 State st., New York City	LaGrangeville	56.2	36.5	92.7	99.5	Wappinger limestone.
Sasman, Christopher	Salisbury Center	Salisbury Center	89.7	trace	89.8	89.8	Trenton limestone.
Solvay Process Co.	Syracuse	Jamesville	90.1	2.5	92.6	93.1	Manlius limestone.
Smith, N. T.	Sharon Springs	Sharon Springs	91.4	.9	92.3	92.4	Manlius limestone.
Sugar River Stone Co.	Boonville	Boonville	90.9	1.3	92.2	92.4	Lowville limestone.
Upper Hudson Stone Co.	26 Courtlandt St., New York City	Verplanck Point	50.4	34.6	85.0	91.6	Inwood limestone.
Worlock Stone Co.	Canastota	Canastota	93.6	.9	94.5	94.7	Manlius limestone.

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[1] Marl.

[2] Average analysis of samples taken from face of quarry before company began grinding.

[3] Samples sent in by Mr. Harris.

Hydrated lime is less concentrated than burned lime, as the quicklime takes up about one-fourth of its weight of water in hydrating, or slaking.

Speaking generally, a ton of ground limestone, 1500 pounds of hydrated lime, or 1200 pounds of burned lime, contain the same amount of soil-sweetening chemicals.

Air-slaked lime, when the process is fully complete, is the same in chemical composition as ground limestone, as it has taken from the air the carbon dioxide driven from the limestone by burning, and has again become lime carbonate. It is of equal value with ground limestone from the same quarry; and of no *greater* value unless fineness be financially worth while.

Marl is also lime carbonate and equal to ground limestone in value, if of similar purity.

Great fineness not required.

The greater coarseness of the particles of ground limestone is not a disadvantage in rational liming. Theoretically, the extremely fine particles in burned lime should be more readily distributed through the soil and thus more quickly come in contact with the acid compounds there, neutralizing them and sweetening the soil. Practically, the fineness, below a certain point, is of little or no advantage. Limestone, ground so all the material will pass through a sieve with ten meshes to the linear inch, includes more than 40 per ct. of particles that will pass a 40-mesh sieve, and from 70 to 90 per ct. that will pass a 20-mesh sieve. Applied in considerable quantity, once in a three-year to five-year rotation, ground limestone of this fineness adds to the soil a large amount of fine particles to act promptly, and leaves a reserve supply of larger grains to dissolve more slowly in the soil solution and thus to keep the soil sweet for subsequent crops. The many experiments at various stations prove that the extra fineness of slaked and hydrated limes gives no better results in a rotation than the somewhat coarser particles of the ground stone that pass the 10-mesh sieve. All the fine material produced by grinding must be included, however; none must be sifted out to sell as finer grade.

HOW USE GROUND LIMESTONE?

Use freely.

On most soils of the State that are in need of lime at all, at least two tons to the acre of ground limestone should be used as an initial application, to be followed by a ton to two tons once in every rotation of three to six years. On some soils, however, particularly the hill lands of southern New York, three or even four tons may be found necessary and profitable. In preparing for alfalfa, particularly on poor soils, four to six tons of limestone may be advisable; since the alfalfa should remain on the land for several years and requires large amounts of lime for plant food, as well as enough to correct soil acidity. It is not easy to supply the necessary lime after the alfalfa is established.

Grading limestones. Limestone is composed of calcium oxide or calcium and magnesium oxides in combination with carbon dioxide, or what we know as a carbonate. As the calcium present is always greater in quantity, and usually much greater, than the magnesium, we generally speak of limestone as calcium carbonate. But for soil sweetening power magnesium is of nearly one-fifth more value than an equal weight of calcium. Accordingly in estimating the agricultural value of limestones we use the calcium carbonate as a basis and add to this the amount of magnesium multiplied by 1.19. This gives the " calcium carbonate equivalent ", previously referred to, which is printed in heavy type in the table.

Where obtain limestone? Ground limestone of excellent quality may now be obtained from many companies in this State. The table on pages 4 and 5 gives a list of the limestone quarries of the State, with the companies owning them or handling the products and with chemical analyses showing their relative value. This is expressed as the " calcium carbonate equivalent " as shown in next to the last column. Companies from nearby States also furnish limestone ranging from 86 per ct. to 96 per ct. " calcium carbonate equivalent " as follows: Kelly Island Lime & Transport Co., Youngstown, O.; Security Cement & Lime Co., Berkeley, W. Va.; J. E. Baker & Co., Bainbridge, Pa.; Carbon Limestone Co., Youngstown, O.; Edison Portland Cement Co., Stewartsville, N. J.; Grangers Lime & Marble Co., West Stockbridge, Mass.; Bessemer Limestone Co., Youngstown, O.

How and when apply. Some field tests may be used to ascertain the need of liming. Soils with a light color, gray, grayish brown, or yellowish in shade are usually in need of lime; and wherever serious difficulty is experienced in growing good crops of red clover or alfalfa a lack of lime is strongly indicated.

If in doubt, the litmus test gives quite reliable indications. It may be made as follows: Obtain a ball of wet soil about the size of the fist, break it open and insert a double thickness of blue litmus paper (obtainable at any drug store). Press the ball firmly together and allow to stand as much as a half hour. If at the end of this time the paper in contact with the soil has distinctly changed to a pink color there is positive evidence of acidity and it may safely be assumed that benefit will follow liming. Of course it is best to make a number of tests in different parts of the field and the subsoil should be examined as well as the surface. The practice sometimes recommended of placing a piece of filter paper between the litmus paper and the soil renders the test of no value. The litmus must come in direct contact with the soil.

Limestone can best be applied by means of a special lime or fertilizer distributor; as it can be spread more thoroughly and with less labor in this way than if applied by hand or by a manure spreader. The fertilizer attachment of a grain drill has too small capacity for practical use in distributing limestone. It is best to apply the limestone to the rough ground after plowing, thus mixing it more thoroughly with the soil by disking and harrowing. It is in the line of good practice to apply any form of lime as long as practicable before seeding the first crop to be benefited by its application. Fall-plowed land furnishes an excellent opportunity for the application of limestone. Also summer-plowed land, to be seeded to grain in the fall and to clover or grass the following spring, furnishes a good opportunity for its application. In general it is much better to apply limestone in the summer and fall when the roads are good, the land firm, and work not so pressing, rather than in the spring when there is haste to get in the crops and conditions are not so good for hauling and applying.

CONTROLLING PLANT LICE IN APPLE ORCHARDS.*

F. H. HALL.

Well-protected plant pests.

Though small and soft-bodied, plant lice on large trees are among the most difficult to control of all plant pests. Three species of these insects attack the foliage and fruit of apple trees, which are commonly known as the rosy aphis, the green aphis and the oat aphis. All are injurious pests in bearing apple orchards, but the two former normally cause the greatest losses in yields. The eggs, in which stage the insects pass the winter, are well concealed in crevices in the bark or at the bases of the buds, so that it is difficult to reach them with any spray, and to most of such mixtures these eggs appear to be quite resistant. The young aphids should be quite susceptible to any of the contact insecticides, but, unfortunately, they remain in the open where sprays can easily reach them only a very short time. The eggs hatch just before, or as, the apple buds begin to expand; and the tiny lice, not much more than microscopic in size, seek immediately the opening bud-tips where green first shows. At this time, and practically at this time only, can the fight against the three aphids on the apple be successfully waged; for within a very short time the insects work into the interior of the buds where the hairy growth of the opening leaves and the rudimentary flower buds protect them. As the leaves unfold the lice feed mostly on the undersides of them, causing the tissues to contract and curling the leaves about the insects so that they are again well protected from spraying.

Damage.

Small though they are, the plant lice can do severe injury, even on orchard trees, for they multiply very fast, the females bringing forth broods of living young in rapid succession and great in number. The greatest harm to apples is done by the earlier broods; for the attacks of the insects at this time seem to do damage out of all proportion to the numbers of insects. The first brood checks the growth of the young leaves and retards the development of the blossoms; while the ones that follow, sucking out considerable quantities of the vital plant juices at the time when these are most needed for the development of the seeds and the tissues of the young fruits surrounding the seeds, may seriously dwarf and deform the developing apples and defoliate the stems that bear them.

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* A reprint of Popular Edition of Bulletin No. 402, April, 1915; for complete edition see p. 385.

Control experiments. These facts relative to the difficulty of control of aphids on apples have been developed in long series of experiments — by the Station alone, by the Station in cooperation with inspectors of the State Department of Agriculture, and by the Station in cooperation with farmers. The first series, extending from 1905 to 1911, demonstrated the difficulty of controlling the plant lice after the leaves were curled, the conclusion being that if any real benefit is to come from the spraying, the applications should be made before the forming apples have received any injury; that is, spraying when the buds are breaking, or just before or just after blossoming.

In the years from 1912 to 1914 inclusive, experiments in cooperation with the Department were conducted in fifteen different orchards, and experiments in cooperation with farmers in nearly 30 orchards to test time of applications, materials to be used, and methods of applying.

All these tests emphasize the necessity of spraying at the proper time; which is, preferably, when the buds are just swelling, as shown in Fig. 1 on page 6. When the buds have reached the stage shown in Fig. 2 the lice are so well protected that efficient spraying cannot be done.

Later applications. The grower should endeavor to combat the pest by the foregoing measures and thus avoid, if possible, the necessity of later sprayings. There are serious objections to late applications because of the danger of early injuries by the insects to fruit and leaf clusters and the difficulty of reaching the lice in the curled leaves, which becomes greater as the infestation increases. If bud treatment has been omitted or this application has not given entirely satisfactory results, one should spray with one of the following mixtures as soon as the aphides are detected in numbers, endeavoring by high pressures to reach as many of the creatures as possible. The amount of protection that will be gained by this spraying will not prove as great as that of the early treatment. However, it will afford some measure of relief and perhaps tide the trees over a critical period.

Formulas for spray mixtures.

FORMULA I, NICOTINE SOLUTION.

Nicotine solution 40 per ct.	¾ pt.
Water	100 gals.
Soap	3 to 5 lbs.

This mixture will cost about $1.15 per 100 gallons. In combining nicotine solution with lime-sulphur omit the soap.

FORMULA 2, KEROSENE EMULSION.

Kerosene	2 gals.
Fish-oil soap	½ lb.
Soft water	1 gal.

Directions for making kerosene emulsion are as follows:

Dissolve the soap, which has been finely divided, in one gallon of boiling water. Remove the vessel from the stove and add the oil. Then agitate the mixture violently for from three to five minutes by pumping into itself under high pressure until a creamy mass is formed, from which the oil does not separate. Fruit growers are advised not to employ an emulsion which shows a separation of the oil as application of such preparations may cause injuries to the trees. This is used with success by some growers for summer spraying against the lice at a dilution of one gallon of the emulsion to eight gallons of water. This emulsion, when diluted as recommended, will cost about $1.08 per 100 gallons.

FORMULA 3, FISH OIL SOAP.

Fish oil soap	12 to 20 lbs.
Water	100 gals.

To prepare for use, slice the soap and dissolve in boiling water. Soap varies greatly in its water content, and before undertaking extensive operations the grower should make a preliminary test to determine the amount of material required to make an efficient spray. Soap used in the proportions as given will cost from 75 cents to $1.20 per 100 gallons.

Combinations of spraying materials. Many pests of fruit trees pursue their injurious activities at similar periods of time and some of them are jointly susceptible to a single application of an insecticide or to a combination of spraying materials. As the expense of insecticides is usually much less than the cost of labor and team, it is desirable from the standpoints of economy and time to reduce the number of applications to the minimum. One means to this end is to employ combination mixtures or, as they are popularly called "two in one" or "three in one" sprays, according to the number and nature of constituents contained in them.

From the standpoint of safety to expanding buds and leaf tissues, and effectiveness against insects, the most satisfactory combination is three-fourths of a pint of nicotine solution (40 per ct.) to lime-sulphur solution at winter strength for bud treatment, or to lime-sulphur at summer strength with arsenate of lead for foliage applications. While this combination lacks somewhat the spreading properties of soap mixtures, oil emulsions or of nicotine with soap, this deficiency is probably more than compensated by the saving in labor in avoiding an extra application and by the thoroughness of spraying in the bud treatment when lime-sulphur is directed also against the San Jose scale.

Sodium and potassium sulphides may be combined with soap or oil emulsions, but they should be regarded as experimental mixtures until there is more knowledge of their insecticidal properties and of the effects of strong preparations of these sulphides on leaf and fruit tissues, especially in combination with common arsenicals.

Directions for bud spraying.

On the basis of the experiments previously described the most effective means of combating the lice is a thorough spraying of the trees at the time when the insects are assembled on the tips of the buds showing green and while the buds are compact. As the creatures that appear on the opening buds are the progenitors of many broods that are to follow, and constitute the first and only forms that infest leaf and fruit clusters at this period, special efforts should be made to allow as few as possible of the insects to escape this treatment. It should, therefore, be the aim of the orchardist to kill all of the insects, and work so directed will destroy from 95 to 98 per ct. of the creatures. To this end apply the spraying mixture in liberal quantities and under high pressures, endeavoring to wet all of the buds.

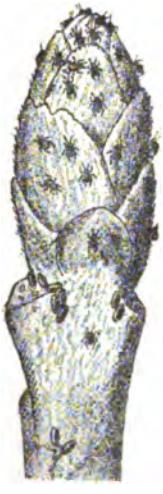

FIG. 7.—APHIDES ON OPENING BUDS; PERIOD FOR FIRST SPRAYING.

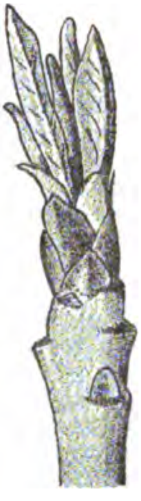

FIG. 8.—APPLE BUDS TOO FAR ADVANCED FOR EFFICIENT SPRAYING.

Conditions determine time to spray.

It is common knowledge that varieties differ as to the time of opening of buds, and that trees of the same variety may show retarded or accelerated growth, according to the conditions of its environment. For these reasons the grower needs to take into consideration the stages of growth of the different varieties, waiting until the lice are massed on the opening buds and keeping in mind the importance of killing the insects before they obtain protection in fuzzy, unfolding leaves of the opening buds.

DWARF APPLES NOT COMMERCIALLY PROMISING.*

F. H. HALL.

Advantages of dwarf apples few.

After a ten-year test in three orchards, under widely varying climatic and soil conditions, the Station cannot recommend dwarf apple trees for the professional grower. They come into bearing but little, if any, earlier than standard trees of the same varieties, and the amount of fruit so produced is too small to make the difference in bearing age of the two classes of trees of commercial value. Though ten years is too short a time to test productiveness thoroughly, there are no indications that the larger number of dwarf trees on an acre will yield more fruit than the proper number of standard trees.

In these experiments, also, the fruit on the dwarf trees was not, nor did it appear as though it would ever be, larger, handsomer or better flavored than that on full-sized trees of the same kinds.

The small size of the trees on dwarfing stocks makes it possible to grow more trees, and, consequently, more varieties, if desired, on a given area, and the dwarfed trees are more ornamental than standards. These points may make trees of this type useful and valuable to the amateur grower; but they are of no advantage to the commercial orchardist.

Some disadvantages.

On the other hand, dwarf trees have several disadvantages that prevent their selection by growers of fruit for market. There is great confusion in apple stocks in America, as well as in Europe, and it is difficult, and sometimes proves impossible, to get trees on the dwarfing stock desired. This is a distinct detriment; for a half-dwarf tree, where one desires a true dwarf, is almost as much out of place as would be a standard. Dwarfed trees are usually sold at a higher price per tree than standards, which gives a very high acre-cost since from four to nine times as many dwarfs would be needed as standards.

In the cold climate of New York, semi-dwarf and dwarf trees, particularly the latter, are very liable to winter injury or to winter killing.

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* A reprint of Popular Edition of Bulletin No. 406, May, 1915; for complete edition see p. 518.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTE
SIONER OF AGRICULTURE DURING 1915 (contin

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS	
			Nitrogen	Ph A
LUDLAM CO., FREDERICK, NEW YORK, N. Y.				
Ludlam's A. B. F. Fertilizer Babylon	6070	G* F*	1.65 1.56	
Ludlam's Cecrops Fertilizer No. 1 Calverton	6072	G F	3.29 3.38	
Ludlam's Cecrops Fertilizer Revised New Woodstock	019	G F	3.2 3.2	
Ludlam's Fruit and Vine Fertilizer Revised Babylon	6068	G F	1. 1	
Ludlam's Long Island Special Potato Fertilizer Revised New Hyde Park	0698	G F		
Ludlam's Palmetto Fertilizer Revised New Woodstock	018	G F		
Ludlam's Sickler Phosphate Revised Erieville	020			
Ludlam's Special Potato Fertilizer Revised Babylon	60			
Nitrate of Soda Calverton				
LYON, S. G., AURORA, N. Y.				
S. G. Lyon's Ammoniated B Superphosphate Aurora				
MAPES FORMULA & PERUVIAN Co., THE, NEW YORK, N				
Mapes General Crop Brand Mount Kisco				

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* These letters indicate, res

of 1903, with trees one year
in the autumn of 1904 with
rees were cut to whips at
owth was none too vigorous
enough buds to make satis-
ter to grow the trees a year
ls there, in part, at least.
w a permanent orchard of
-with fillers on Doucin stock
nd, between these, fillers on
s. In the Wood orchard the
her two orchards twelve feet.
ed to 306 trees on the three
n Doucin stock, 153 trees; on
among the following varieties:
ubbardston, Jonathan, Lady,
ton, Wealthy and Wagener.
vith 512 trees, the number on
icin, 161; Paradise, 309. The
ler, Baldwin, Boiken, Esopus,
-, Hubbardston, Jacob Sweet,
mouth, Northern Spy, Pumpkin
tton, Wagener, Wealthy, Wolf

originally 375 trees: 45 on stand-
'aradise stocks, distributed among
Ben Davis, Boiken, Gravenstein,
ly, McIntosh, Monmouth, R. I.
rk, Twenty Ounce and Wealthy.
n, with cover crops, usually legumes,
as the method of tillage in each
h was followed throughout with slight
onditions demanded; and the trees
henever necessary. Much time and
removing suckers and cion roots,
es true to type and to maintain
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made it difficult to secure
pruning was not unlike that
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summer pruning

The union between stock and cion is not as good with dwarf trees as with standards, consequently more dwarf trees break off and are lost.

To maintain the trees as dwarfs requires watchfulness and labor, since the cions frequently throw out roots if the union is at or near the surface of the ground. These roots must be removed or the trees quickly cease to be dwarfs.

The rooting system of dwarfing stocks is relatively shallow, which results in several disadvantages: The dwarf trees are easily blown over, particularly when heavy with fruit; they suffer more from drought than do the deeper-rooting standard trees, and they cannot be so thoroughly cultivated to conserve the moisture because of the shallow-rooting habit; in cultivating root injuries are frequent, leading to lessened vitality of the tree, to ready entrance of disease, and to the formation of suckers, a vexatious trouble of dwarf stocks. Suckering is due also, no doubt, to the fact that dwarf stocks are usually propagated from cuttings or layers.

To maintain the trees as dwarfs some summer pruning is necessary, and it has been found impossible during the ten years to find a method and a time that will assure satisfactory results from summer pruning. On the one hand, the results for which summer pruning is done, maintenance of dwarfness and promotion of fruitfulness, do not always follow; and, on the other hand, positive harm often results because of the weak, sickly, second growth which often is an after effect, and which nearly always succumbs the following winter.

The tests in brief.

The Station tests really owe their origin to the feeling, some fifteen years ago, that San José scale had come to New York State to stay and that it could probably be controlled only by fumigating the trees under tents. This would be, practically, an impossibility with mature standard trees, but would be a feasible method with dwarfs. Could dwarfs be substituted for standards and the productivity of New York orchards still be maintained? Interest in dwarf apples had also been stimulated from various quarters and it was held that advantages aside from ease in scale control made them a commercial possibility.

Accordingly the Station, at the request of various horticultural organizations, began an investigation with trees of this type and set three orchards, in cooperation with the owners. These were on the farms, respectively, of Edward Van Alstyne at Kinderhook in the Hudson Valley, of F. E. Dawley at Fayetteville in central New York, and of Albert Wood & Son at Carlton, in great western New York apple region.

These orchards are as diverse in soil and climatic conditions as they are separated in distance; so that success or failure in them should prove the applicability, or the reverse, of dwarf-apple culture in the whole state.

The Wood orchard was set in the fall of 1908, with trees one year from the bud. The other two were set in the autumn of 1904 with trees two years from the bud. The trees were cut to whips at planting, which proved a bad plan, as growth was none too vigorous and many of the trees failed to put out enough buds to make satisfactory heads. It would have been better to grow the trees a year longer in the nursery and form the heads there, in part, at least.

In each case it was planned to grow a permanent orchard of standard trees,—on French crab stock,—with fillers on Doucin stock — which produces half-dwarf trees — and, between these, fillers on Paradise stock — which gives true dwarfs. In the Wood orchard the trees were set fifteen feet apart, in the other two orchards twelve feet.

The Van Alstyne orchard was planted to 306 trees on the three stocks as follows: Standard trees, 27; on Doucin stock, 153 trees; on Paradise, 126. These were distributed among the following varieties: Baldwin, Boiken, Holland Pippin, Hubbardston, Jonathan, Lady, McIntosh, R. I. Greening, Rome, Sutton, Wealthy and Wagener.

The Dawley orchard was planted with 512 trees, the number on each stock being: Standard, 42; Doucin, 161; Paradise, 309. The following are the varieties: Alexander, Baldwin, Boiken, Esopus, Gravenstein, Green Sweet, Grimes, Hubbardston, Jacob Sweet, Jonathan, Longfield, McIntosh, Monmouth, Northern Spy, Pumpkin Sweet, R. I. Greening, Rome, Sutton, Wagener, Wealthy, Wolf River, Yellow Transparent.

In the Wood orchard there were originally 375 trees: 45 on standard, 110 on Doucin and 220 on Paradise stocks, distributed among the varieties Alexander, Baldwin, Ben Davis, Boiken, Gravenstein, Holland Winter, Jonathan, Lady, McIntosh, Monmouth, R. I. Greening, Rome, Sutton, Bismark, Twenty Ounce and Wealthy.

Care of the orchards.

Clean cultivation, with cover crops, usually legumes, was adopted as the method of tillage in each orchard, which was followed throughout with slight changes as conditions demanded; and the trees were sprayed whenever necessary. Much time and labor had to be given each year to removing suckers and cion roots, operations essential to keep the trees true to type and to maintain their vigor. Pruning also was a perplexing problem, since the severe trimming of the trees at setting made it difficult to secure good heads in many cases. The winter pruning was not unlike that of standards, though more heading back was needed to restrict the size of the trees. Summer pruning is a necessity in the successful culture of dwarf trees, but no satisfactory system was developed by a series of experiments in the three orchards extending over ten years in time. "We have been forced to conclude that the great variations in temperature and moisture in the summer and the cold winters in New York almost or quite debar the summer pruning here that is practical in the Old World."

The usual orchard mishaps occurred, like failure of trees to grow, girdling by mice, injury by stray animals, death from blight or from unknown causes, but the percentage of loss was small from these incidental perils of all orchard culture; but it was large from those apparently due to the dwarfness of the trees. Many trees winter killed; many failed to make a good union, with death or failure as the result; and the surface-rooting habit caused an unexpected number of deaths and failures. At the end of the tests the number of missing or replaced trees was quite too large for profitable orcharding.

Fruit bearing.

Contrary to what has been generally claimed for dwarf trees, ten years from bud proved too short a time to give satisfactory data regarding productiveness. This is in part, undoubtedly, due to the whip-pruning of the trees at setting, the severe pruning necessary later to secure good heads, and the experiments in summer pruning; but the dwarfness of trees on either Doucin or Paradise stock has not induced notably earlier fruiting. In all three orchards the Paradise trees came in bearing soonest; but in no one of the three orchards was there what could be called a commercial crop on any of the stocks until the tenth year after setting. Then, taking an average of the three orchards, the standard trees bore 66½ pounds each, those on Doucin 63⅔ pounds and those on Paradise 52 pounds.

Computed on the acre basis, this would make the Paradise most productive for the first ten years, Doucin next and standards last, the acre yields thus coming in the order of dwarfness. But so many exceptions could rightly be made to this calculation that it is hardly worth making. Those who have watched the experiment have been surprised at the comparatively small yield of the Paradise trees. Few, indeed, are the trees of this true dwarf type that have been bent to the ground with a load of fruit as they have been so often depicted.

The figures are hardly fair to the dwarfing stocks; for the orchard conditions in this test have been better suited to the standard trees so that both in matter of yield and in time of coming in bearing, the figures favor the standards. On the other hand there is no question but that the eye always favors the dwarf trees. Such trees are seen loaded with fruit and the conclusion follows that they have come in bearing earlier and are more productive than larger trees which really bear more fruit, either per tree or per acre, though seeming to carry less. Dwarfs are much more spectacular than standard trees—hence, in part, their reputation for early and productive bearing.

The same is true also regarding the color and quality of the fruit on trees of the two types. The fruit on the dwarf tree is close to the eye and therefore in stronger contrast with the foliage, so it appears larger and brighter than that on larger trees; but when picked and compared it would be almost impossible to tell from which type

of tree the fruit came. Again, dwarf t
more severely, the crop thinned, and
better care, which, of course, make a mo
grown on less well cared for standards.
identical conditions as possible, as on th
doubtful whether there is much difference
on the three stocks.

(Plates XLV and XLVI were printed

MILK RECEIVES FEW BACTERIA FROM STABLE AIR.*

F. H. HALL.

False idea overthrown.

Careful investigation of pure milk problems is proving that many current beliefs and practices are ill founded. The importance of many factors has been overestimated, as shown in recent bulletins of this Station, which prove (1) that over-refinement in securing stable cleanliness and in certain grooming processes is without effect in reducing the number of bacteria in the milk, (2) that cooling and straining the milk need not increase bacterial contamination if the utensils used are carefully sterilized, and (3) that dairy score cards are not reliable indexes to the quality of the milk produced in the stables scored. On the other hand, the value of other agencies has been under-estimated; since researches at this Station and elsewhere prove (1) that reducing the size of the pail mouth lowers very materially the number of germs in the milk, (2) that thorough sterilization of pails and other utensils and their protection from contamination previous to use are more important measures than they have previously been thought; and (3) that, with some cows, the interior of the udder supplies large numbers of bacteria to the milk.

An over-emphasized factor, as proven by investigations here reported, is the influence of stable air on the bacteria content of milk. Practically all the dairy score cards now in use give several points to stable air and cut severely for conditions that tend to increase the quantity of dust therein or to disturb the air so that the dust will move about more freely. Cuts are also given for indications that dust has previously been in the air, such as its presence on ledges, shelves, tops of mangers, feed racks and similar places. Yet the very careful studies here reported prove clearly that the air of the stable, under any ordinary conditions of dustiness or disturbance, is an almost negligible factor so far as it affects the numbers of bacteria in the milk produced.

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* A reprint of Popular Edition of Bulletin No. 409, August, 1915; for complete edition see p. 151.

Preliminary work.

Before practical studies could be satisfactorily carried on to determine the number of bacteria in stable air and in the milk drawn in the stable it was necessary to test the accuracy of the methods used. Months of careful work were spent in experiments with different types of "aeroscopes" or air filters, and in comparing methods of measuring bacterial precipitation from the air. In air filtration, a fixed quantity of air is drawn through the apparatus by the flow of water from a bottle of known capacity, the air passing through the filter to take the place of the water drawn out. Air filters are of two general types. Very fine sand is used as the filtering material in one form; and water or some other liquid is used in the other type to catch and hold the bacteria.

As air, even under slight pressure, will pass through very minute crevices or holes, many precautions must be taken not only to make an air-filtering apparatus tight so far as outside air is concerned, but also to make the filters perfect. If these are of sand, no crevices or channels must be left through which air can flow instead of filter; and if the bacteria-retaining material be liquid the air must be made to pass through in such a way that no bacteria can escape in large bubbles.

Much care must also be used, with bodies so small as bacteria, lest some of those in the air stop on the way through the aeroscope by adhesion to the walls of the tubes or bottles used and so escape counting. These and many other minor points in connection with the filtering devices were studied in about 400 tests, from two to six or more comparisons being made in each test. Additional work was also required, involving 40 more tests, to compare the counts of bacteria caught either on exposed plates of culture media or in pails of water, from which culture plates were subsequently made.

Apparatus and methods adopted.

As a result of these long series of tests, a modified type of aeroscope was developed and adopted for use in measuring the bacteria actually in the air. For estimating the number of germs that would fall from the air in any given time, precipitation into pails of liquid was found preferable to precipitation upon the more commonly used plates of culture media.

Both the standard sand-filter aeroscope and the Rettger liquid-filter type were found to give dependable and accurate results under proper conditions; but because it overcame certain annoying difficulties and was more convenient in work of this character, the modified standard apparatus was selected for the final tests. By this modification, developed in the course of the present investigation, a fused union of two glass tubes is substituted for a cork connection, with its greater chance of leakage; and dry sterilization can be used instead of the steam sterilization necessary with the original standard apparatus, which often leads to caking of the sand and the formation of channels and crevices.

Although the plate-exposure method for counting the bacteria falling from the air has been used in nearly all studies of this kind previously made, it was found to give much smaller counts than the pail-exposure method, consequently the latter was chosen for this work. As the average of all the tests made, ten times as many bacteria were found by the pail method as by the plate method. In the comparisons most favorable to the plate method only one-half as many bacteria were counted as by the pail method, while in the least favorable cases the ratio was as great as 1 to 32. This failure of the plate method to show all the bacteria is undoubtedly due to the fact that on plates only one colony may develop from a dust particle laden with many bacteria, while by the pail method these collected bacteria are separated and more individuals may grow into colonies on the culture plate. These conditions correspond quite closely to those in the milk after dust particles enter it.

Practical studies: Methods.

From these preliminary investigations and from studies of indirect data derived from several sources, it was believed "that the number of bacteria gaining access to the milk from the air is relatively small in comparison with the numbers derived from the interior of the udder, the exterior of the cow, and the pail," consequently every effort was made during the actual study of the bacteria in, or from, the air to get rid of these other factors so far as possible. An apparatus was devised by which it was possible to shut out contamination from these sources and to distinguish quite satisfactorily between the "washing" effect of milk sprayed through the air in milking and the unaided falling of bacteria into the pail as sources of contamination of the milk. The "artificial cow" used to make these "milking" tests is shown on page 180. This consists of a can or "udder" above the protective platform corresponding to the lower surface of a cow's body, and two glass and rubber "teats" below through which water or other liquid can be sprayed or "milked," either continuously or intermittently as in actual milking, into the pail below. All necessary precautions were taken to make distances and other conditions about this apparatus, when in use, correspond as closely as possible to those beneath the cow. Tests with this apparatus and with the aeroscopes were made simultaneously for the pairs or groups of comparisons, sometimes requiring two or three persons to perform the necessary operations and make the records: (1) The air was analyzed for bacteria, using the modified standard aeroscope, which was clamped in position under the platform beside the two pails; (2) the "milking" was carried on, with sterilized water, drawn into sterilized test tubes for a check and then into the pail; (3) a pail under the platform, containing sterilized water, was exposed for a definite period and then protected against further contamination. (4) similar determinations of the amount of precipitation in the open stable were made by placing pails on the floor beside the apparatus.

The plating, incubation of the bacteria and other analytical processes, were made by methods previously found to give reliable results, and were kept as uniform as possible throughout any series of tests.

Practical studies: Conditions.

This "artificial cow" and the aeroscopes were used under many different conditions and in different places in order to study the effect of various stable operations, disturbances of the air and ranges of dustiness upon the numbers of bacteria present or precipitated into the milk.

In the Station stable two series of tests were made during afternoons with the cows in the stable, part of the series when grain was being fed, part while the cows were being milked and one test while the cows were being brushed; and another series was carried through in the morning while the cows were being fed chopped hay.

As none of these tests showed high numbers of bacteria, in the air, falling into the pail from the air, or washed out of it by the milking, conditions were made more severe, equalling or exceeding any that would ever be met in stables. The pieces of apparatus were moved to the stable loft, in the upper story of the large cattle barn, and dust raised artificially.

In the first series a dense dust was raised before each test by stirring up the hay and dirt on the floor of the loft; and in the second series the extremely dusty condition was maintained throughout each test by continuous stirring and sweeping of the refuse on the floor.

As the Station stable presents some unusual conditions, it was thought wise to carry the investigation into commercial dairy stables where surroundings were in every way typical of those ordinarily met, from good to bad; not as complete series could be conducted as in the Station stable, owing to the distance of the stables from the laboratory.

However, analyses of the barn air were made in fifteen tests, five in summer and ten in winter, in one old stable (A) quite well cared for but with dust in the air very evident at the time of each of the tests. Conditions were made very bad during three of the tests by throwing down hay and feeding, while during half of the remaining tests the cows were eating dry hay and in the other half milking was in progress. The second stable (B) had been more recently constructed than the first one; but was poorly cared for, the cows were not brushed, were covered with dust, and occasional ones had dried manure clinging to their flanks. Dry feed was given to the cows after milking, however, and the air was not noticeably dusty at the three visits made to the stable, in July, January and March respectively. The twenty-three tests were made just before milking, during milking, and while the cows were being bedded.

The third stable (C) is one of the most poorly constructed and poorly kept stables in the vicinity, located in the basement of the barn, very poorly lighted and ventilated, the mangers and other fittings are of wood, the floor, except immediately under the cows, of dirt, pulverized into fine dust, the walls back of the cows spattered with dry manure, and dust and cobwebs abundant. Twenty analyses were made here, all in March, but under widely varying conditions, such as with barn empty, empty except for calves and chickens, empty but man removing manure and corn stover, cows coming in, while straw bedding was being placed, cows in stable and receiving grain feed, cows being brushed, and cows being milked.

Practical studies: Results.

In this wide range of conditions the variations in the numbers of bacteria found were, of course, great; but except under circumstances that would never long continue in ordinary stables, the number of germs finding their way into the milk was so small as to be almost negligible.

The first table below shows the average number of bacteria in the air of the Station stable or loft in groups of tests, with the interpretation of these numbers in terms of bacteria falling into the milk or " washed " into it by the milking.

TABLE I.— ANALYSES SUMMARIZED ACCORDING TO THE NUMBER OF BACTERIA PER LITER OF AIR.

GERM CONTENT PER LITER OF AIR BETWEEN —	Number of tests made.	Average count per liter of air.	AVERAGE PRECIPITATION IN 5 MINUTES.		Bacteria washed out of air by " milk " stream.	Total germ content* in " milk."
			Per sq. cm. under " cow."	Per c. c. of fluid " milked."		
0-100	26	51	49	1.8	5.2	7.0
101-1,000	19	312	210	6.6	26.6	33.2
1,001-10,000	33	3,270	3,581	94.0	101.0	195.0
10,000 and upwards	7	18,644	24,264	611.0	326.0	937.0

* The figures in this column are the sum of those in two preceding columns.

It will be noted that even when the dustiest possible conditions were secured so that the bacteria averaged more than 10,000 per liter of air, which happened in seven tests only, less than 1000 germs per cubic centimeter got into the milk, while in 78 tests the number was less than 200, and in 45 tests, or more than half of all, the figure was below 50, a quantity so small that the presence or absence of these bacteria could not be detected, except in the very highest grade of milk, by any method of bacterial analysis.

In the next table the analyses made in the Station stable are grouped in accordance with the barn operations then in progress.

TABLE II.—ANALYSES SUMMARIZED ACCORDING TO THE BARN OPERATION IN PROGRESS AT THE TIME OF MAKING THE ANALYSIS.

BARN OPERATION IN PROGRESS AT THE TIME THE ANALYSIS WAS MADE.	Number of analyses made.	Average germ content per liter of air.
1. Barn empty, everything quiet	60	41
2. Barn empty, sweeping floor or dusting off stanchions	7	135
3. Cows in barn, everything quiet	20	94
4. Brushing off cows	33	130
5. Feeding dry grain	50	124
6. Brushing off cows when test was started. Feeding grain at end of test	8	190
7. Feeding grain at beginning of test. Milking started before test was finished	11	235
8. Milking in progress	153	111
9. Feeding silage just after milking was finished	10	271

Under none of these conditions did the average number of bacteria in the air reach 300 per liter, and in no case would the increase in the number of bacteria from the air reaching the milk drawn under these conditions be measurable.

Similar results were secured in the commercial stables; for in the best stable (B) the number of bacteria per liter of air did not reach 1000 in any of the 23 tests, was above 500 in only four tests and was 100 or less in nearly half of them. In A, the bacteria in the air were above 1000 in only two tests, in one case only slightly above this figure when the air was analyzed shortly after the cows had come into the barn and were being milked, but in the other case reaching 16,000, before the cows were milked and while dusty hay was being thrown down for them. In the other tests, the germ content of the air ranged from 4 to 857 per liter and averaged less than 350.

In C, only two analyses showed more than 1000 bacteria per liter of air, and these were both less than 4000, with quite evident reason for the increase over the other analyses through the removal of corn stover and feeding of grain during or shortly before the taking of the air samples. In this stable many tests showed less than 100 bacteria per liter of air, with a very low average for all.

In these stables, except in perhaps one instance, it would have been impossible to detect the addition of bacteria from the air by any analysis made of the milk.

Similar " precipitation " tests were made to compare the numbers of bacteria falling into open-top and small-top pails exposed in the stable during different barn operations, each exposure continuing five minutes, approximately the time required to milk a cow. These results are summarized in Table III; and in Table IV are given computed data showing the numbers of bacteria in the milk resulting from longer exposure, and with greater numbers of germs in the air, as in the tests in the stable loft.

TABLE III.—RESULTS OBTAINED BY EXPOSING A STERILE LIQUID IN PAILS TO THE AIR OF THE OPEN STABLE.

Summarized according to the barn operation in progress at the time the test was made.

BARN OPERATION.	Pail.	Number of tests.	Precipitations on 1 sq. cm. in 5 min.	CALCULATED NUMBER OF BACTERIA WHICH WOULD BE ADDED TO THE MILK PER C.C. IN				
				1 min.	5 min.	15 min.	30 min.	60 min
Feeding dry drain	Loy....	7	71	0.40	2.02	6.05	12.1	24.2
	Open...	7	71	2.07	10.35	31.05	62.1	124.0
Feeding dry chopped hay.	Loy....	22	55	0.30	1.56	4.69	9.4	18.7
	Open...	22	55	1.60	8.02	24.06	48.0	96.0
Milking.........	Loy....	25	114	0.6	3.20	9.60	19.2	38.0
	Open...	25	114	3.3	16.6	49.8	99.6	199.0

TABLE IV.—CALCULATED NUMBER OF BACTERIA WHICH WOULD FALL INTO AN OPEN MILK PAIL IN GIVEN LENGTHS OF TIME

ASSUMED PRECIPITATION ON 1 SQUARE CENTIMETER IN 5 MINUTES.	CALCULATED NUMBER OF BACTERIA WHICH WOULD BE ADDED TO THE MILK PER CUBIC CENTIMETER IN				
	1 minute.	5 minutes.	15 minutes.	30 minutes.	60 minutes.
50................	1.5	7.3	21.9	43.7	87.5
100................	2.9	14.6	43.7	87.5	180
250................	7.3	36.5	109	218	437
500................	14.6	72.9	219	437	875
1,000................	29.2	146	437	875	1,750
5,000................	146	729	2,187	4,374	8,748
10,000................	292	1,458	4,374	8,748	17,496
50,000................	1,460	7,290	21,870	43,740	87,480

These tests and computations show that under the worst of the assumed normal conditions, where the milk is allowed to stand an hour in the stable in an open 12-inch pail, the average number of bacteria added to the milk would be only 96 when the cows were being fed dry chopped hay, 124 if they were fed dry grain or 199 if they were being milked. These numbers are so small that the addition of the bacteria could scarcely be detected in any but the highest grade of milk by any known method of analysis. An examination of the results, calculated on the basis of a small-mouthed pail, shows that a five-quart milking could stand in the open stable for one hour or longer without producing any detectable result so far as bacteria added to the milk from the air are concerned.

The lowest and medium results obtained in the stable-loft tests represent conditions that might exist in any stable for a very short time after such dust-producing operations as feeding dry hay or grain, when exposure of milk in the open pail for any considerable time would result in an appreciable addition of bacteria to the milk. The effect of such operations passes quickly; for tests made within 15 minutes after some dust-producing disturbance showed marked reduction of the numbers of bacteria either in air or falling into the milk in that time. The highest of the results secured in the stable loft represent conditions that are scarcely conceivable even in the worst commercial dairies. They could be obtained only by attempting to milk within a few feet of the dusty end of a threshing machine or fanning mill. The precipitation pails exposed under these conditions were covered with a layer of dirt at the end of five minutes. Of course the numbers of bacteria increase very rapidly in exposures under such conditions.

Conclusion. While these investigations show that the numbers of bacteria present in stable air markedly exceed those found for country air, city street air, air of offices, schools or factories, they prove very clearly that the number falling into the milk during milking or during any short exposure in the stable, under conditions allowable in any respectable dairy, is so small as to be negligible. Milking under extremely adverse conditions, like feeding very dusty hay or grain during milking, and especially exposure of milk in the open pail for any considerable time under such conditions, should, of course, be avoided.

A NEW CHERRY AND HAWTHORN PEST.*

F. H. HALL.

Peculiar choice of host plants.

The sour cherry is less subject than most cultivated plants to injury by insects or disease — one of the factors that have made this fruit so popular with growers in recent years. Plum curculio, plant lice, and San Jose scale, all very destructive on other fruit trees, even on the sweet cherry, rarely injure the sour cherry. Within a few years, however, a new pest has become known fortunately, only in a few restricted areas as yet, that selects the sour cherry in preference to the sweet cherry; and, peculiarly enough, it appears to confine its work principally to one variety of the sour cherry, the English Morello. Still more strangely, the same insect attacks the leaves of shrubs and trees of an entirely different species and genus, the hawthorn; and here, also, it does not work indiscriminately, but affects certain species or groups of species severely and allows others very nearly related to remain practically untouched. No satisfactory explanation has been found for this restricted, and yet widely divergent, choice of host plants by this new pest, the cherry and hawthorn sawfly leaf-miner, *Profenusa collaris*.

The insect and its changes.

The adult insects are small, fly-like creatures that appear only for a brief time in late spring and eat little or nothing. Though similar to small flies in general appearance, they are four-winged and have other characters that ally them with bees and wasps, the Hymenoptera. They belong to a group of about 2000 species, the Tenthredinoidea, of which about 700 species are American. These include possibly a dozen injurious forms of which the pear slug, the rose sawfly and the currant worm are probably best known. The name "sawfly" applied to many members of this great group, comes from the fact that the females are provided with toothed ovipositors, of which one part slides upon another with a saw-like motion, thus cutting or sawing the plant tissues so that the eggs may be deposited beneath the surface.

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* A reprint of Popular Edition of Bulletin No. 411, December, 1915; for complete edition see p. 403.

The "flies" of the cherry and hawthorn leaf-miner are about 3–16 of an inch long, mainly black in color, but with some portions of the body tinged reddish and the appendages whitish.

These flies emerge from pupal cells in the ground in early or mid-May when the cherry leaf-buds are opening. They mate at once (or the females, without mating, may lay eggs which produce living larvæ), and place their eggs through the upper surface and close to the lower surface of a cherry or hawthorn leaf. These eggs hatch within a week into tiny, maggot-like larvæ which spend the five stages of their larval life inside the leaf, each stage being ended by a molt. The development of the larva requires about a month, after which it cuts its way to the surface of the leaf, drops to the ground and forms a hard pupa-case of earth in which to spend the summer, winter and early spring and to change to the adult sawfly.

Work of larvæ.

The larvæ eat the leaf tissue between the two surfaces, forming narrow twisting tunnels, at first near the margin of the leaf, but later, as the tunnels enlarge, working toward the center of the leaf or crossing it at the tip and working down the opposite side. The destruction of the pulpy tissues leaves the upper cuticle or thin membrane covering the leaf, making a wide line, a blister or a patch of grayish brown, dead tissue on the leaf. Sometimes a half dozen miners may work in a single leaf so that a great part of the tissue is destroyed and the blister-like patches become so large that the foliage appears as though struck with a blight. With the cultivated hawthorns, which are used as ornamentals, this disfiguration is sometimes quite serious.

With both cherry and hawthorn, however, the leaves affected are only those that have appeared before the middle of May, since egg-laying by the sawfly ceases about this time, and there is no second brood. The larva remains in the same leaf, so the foliage that unfolds later escapes injury. In ordinary seasons of good leaf-growth, the actual damage to the trees is probably slight, since new leaves soon appear to replace those mutilated. If the conditions should happen to be very unfavorable for foliage production the trees might suffer noticeably from an especially numerous brood of the "miners," and the setting fruit be checked in development. It is very difficult to estimate the damage from such partial defoliation, though, unless it be continued over a considerable period of years.

History and distribution.

The work of the insect was first brought to the attention of the Station Entomologist in 1910, through infested leaves sent by a cherry grower near Geneva. The larvæ from infested leaves came to maturity in 1910 and as they were of an unknown species specimens were sent for identification to an authority in the group to which the insects belong. He found it to be a new species and also placed it in a new genus, but reported that similar specimens, in too poor condition for description, had been found in hawthorn leaves sent from the vicinity of Boston.

Subsequent investigations and search have found the insect at work in several cherry orchards near Geneva, and in others in the Hudson Valley, while it has been discovered in hawthorns about Geneva, Rochester, Ithaca, Skaneateles and New York City. Careful watch has been kept for it in cherry orchards in other parts of the State, but if present elsewhere than about Geneva and Germantown it is probably in very restricted numbers.

Methods of control.

Control methods have been quite thoroughly tested for three years in an orchard near Geneva, but without discovering any certain preventive treatment. The most practicable appears to be the removal and burning of infested leaves in late May or early June, with destruction of wild hawthorns near the cherry orchard and with late summer and early spring plowing and working of the ground to expose the pupa cases to the weather and to birds.

Fumigation with hydrocyanic-acid gas is a sure method of destroying the larvæ in the leaves, but is hardly to be recommended because of the necessity of special equipment, with consequent expense, and the inconvenience.

Spraying with practically all forms of contact insecticides proved ineffective against the larvæ on cherry, hidden as they are inside the leaves; but on hawthorn a strong soap solution, with nicotine, sprayed on the leaves, seemed to penetrate the tunnels and destroy the miners It was found impossible to poison the adults, even by using a sweetened arsenate spray; and very few of them were killed by attempts to reach them with contact insecticides.

Fortunately, at least two natural enemies have been found, one of them a new species, which parasitize the eggs or the larvæ and so destroy them. It is quite probable that these and other enemies, with the ordinary destruction by severe weather, will hold the pest in check except for rare outbreaks.

(Plates XXVIII and XXIX were printed in this Popular Edition.)

WHY AND HOW PASTEURIZE DAIRY BY-PRODUCTS.*

F. H. HALL.

Pasteurization protects health.

Pasteurization of dairy products and by-products serves two purposes, chiefly, of which protection of health is by far the more important. When we demand that the process be applied to milk or cream it is usually in order to prevent danger to ourselves, and particularly to our babies and children, from milk-borne diseases or intestinal troubles due to the germs that cause or accompany milk fermentations. That pasteurization prolongs the period of palatability of milk and cream and thus influences their food value, and that the process enables the buttermaker to secure a better or more uniform product, are incidental benefits that have a direct financial appeal; but it is the argument for "safety first" in milk handling that has compelled the passage of so many laws and ordinances making pasteurization a requirement before milk of uncertain sanitary quality is distributed to consumers.

The same argument for health preservation applies, though less directly, in favor of pasteurizing dairy by-products — skim milk and whey — which serve only rarely as food for man, but most commonly as food for farm animals. The unpasteurized by-products sent back to the farms from skimming stations and butter and cheese factories may carry the germs of disease from any herd in the community to any or all others. Many instances are known in which this has actually occurred. Thus, new animals become infected, and through these animals the danger of spreading disease to human beings is increased and the possibility of eradicating plagues like tuberculosis reduced.

Other benefits from by-product pasteurization

But in favor of pasteurizing dairy by-products, a strong financial appeal can be made: In the first place, the advent of any communicable ailment like tuberculosis or foot-and-mouth disease among a farmer's cattle or swine always means both direct and indirect financial loss; and pasteurization effectively guards one of the avenues by which such diseases come, thus protecting the herd owner against this loss. Second, pasteurization preserves unaltered for considerable periods the palatability and the food value of the by-products and so prevents a financial loss that would otherwise be certain. In unpasteurized whey lactic-acid, alcholic, and other fermentations take place due to the unchecked activities of bacteria and yeasts; and these fermentations lead to changes in the food compounds that lower their energy-producing power in the body. Third, pasteurization prevents some direct losses of food constituents that result from the usual handling of whey, and makes it possible to secure more uniform and more fair distribution of the valuable compounds to the patrons of the factory. In unpasteurized whey the fat soon rises to the top of the whey tank in a layer, so that the first few patrons who dip out whey secure nearly all of the fat; while if the whey is drawn from the bottom of the tank the last man to be served may get the fat. When the whey is pumped from the bottom, the fat remains in the tank, gradually forming an unsightly, ill-smelling mass which is the home of countless millions of germs. In such cases the patrons lose practically all of the food value of the fat. Pasteurization retards the rising of the fat and keeps it evenly distributed throughout the liquid so that it is all drawn out with the whey and fairly divided among the factory patrons. Fourth, pasteurization of whey frees it from many undesirable organisms which cause trouble in making cheese when farmers' cans become seeded with them.

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* A reprint of Popular Edition of Bulletin No. 412, December, 1915; for complete edition see p. 385.

Attempt to secure law fails.

The advantage of pasteurization of dairy by-products and the comparative ease and inexpensiveness of its application have led several states to enact laws making it compulsory at all factories and stations that return by-products to their patrons. The New York State Commission for the Investigation of Bovine Tuberculosis, with other organizations and individuals, urged the passage of such a law for this State in 1914, but failed to secure it. This Commission believes that the opposition to such a law was based largely on ignorance of the good effects of pasteurization and an erroneous idea of the difficulty and expense of pasteurizing products of this character.

Investigation desired.

The Commission requested the Station to make investigations to ascertain the practicability and value of pasteurization and of the conditions necessary to make the process efficient. Cooperation with the Commission was agreed to and series of studies made during the summer and fall of 1915 at seven cheddar cheese factories and two skimming stations where pasteurization of by-products is already in operation though not demanded by law.

It speaks well for the merits of pasteurization to learn that the process has been voluntarily adopted at fifty-five cheese factories in the State; and that, so far as can be learned, it has not been abandoned at any place after its introduction. Patrons of the factories seem sufficiently well pleased with the improvement in the quality of the by-products returned to bear all or nearly all of the slight expense of pasteurizing; and the owners of several large factories see enough benefit from the cheesemaker's side to do the work for less than its actual cost. This cost should not greatly exceed one cent for each hundred pounds of whey and may be as low as one-half cent.

Station studies. In making the investigations a man was sent to the different factories and stations to observe the general arrangements for pasteurization and the actual conditions resulting from its use, to note the temperatures secured during the heating of the whey or skim milk and the rate of cooling as the material passed to and stood in the distributing tank; and to take samples of the by-product before, during and at various intervals after pasteurizing. In a few cases bacteriological examination of these samples was made at or near the factory, but in most instances the bottles were iced and sent as quickly as possible to the Station laboratory where careful study of the samples could be made.

What is legal pasteurization? Pasteurization merely means heating liquids or other materials to such a point that disease germs shall be destroyed and other undesirable organisms so reduced in number that their action shall not become noticeable for a considerable time. Various temperatures and periods of time may be used to secure these results; so it is not surprising to find that the legal requirements for pasteurization differ considerably in different states. A wider range is possible in treating by-products than in heating milk and cream, since too high temperature or too long continued heating affects the flavor of these products and makes them distasteful to many consumers. This slight change in flavor can be disregarded in case of food for animals; so the states compelling pasteurization of by-products usually require temperatures high enough not only to destroy most of the germs present but also to so change the by-product itself that a simple chemical test will show whether or not it has been pasteurized and thus furnish evidence for the prosecution of violators of the law. The Iowa law requires the heating of dairy by-products to 185° F., the Minnesota law to 180° F., and the Pennsylvania law to 178° F., any of which temperatures would insure satisfactory germ control and furnish evidence that the milk had been heated. The Michigan law requires 185° F. for " flash " treatment (heating without holding), but also allows holding at 145° for thirty minutes as an alternative method. This temperature and time will destroy most bacteria and all known disease-causing organisms.

General efficiency of New York pasteurization. In only one of the seven cheese factories visited in connection with the investigations were the temperatures secured in pasteurizing the whey high enough to meet the requirements of any of the laws except those allowed in Michigan for an alternative method. The temperature at the one exceptional factory rarely reached 178° F. Two of the factories did not meet the Michigan "holding" requirements (145° for 30 minutes) and these two lost some of the value of the partial pasteurization by adding separator slop or water to the whey after the temperature was too low to pasteurize the added material. A third factory, though using temperatures high enough to secure efficient pasteurization, made the whole process unsatisfactory by adding unheated liquid to the partially cooled whey.

In four of the seven factories the pasteurization was effective, both as judged by the general condition of the whey in the distributing tank and by the bacterial analysis of the samples taken. In all four of these factories the pasteurization was by means of a steam line running into the whey tank. This is apparently a more effective method than by the addition of steam to the whey or skim milk by the "jetting," or injector-pump, method of transferring the material about the factory and to the distributing tank. One disadvantage of the direct-pipe method is that a factory-man may occasionally shut off the steam supply a little too soon. The addition of steam in the jetting or double "jetting" method is more positive, but is usually insufficient to heat the whey to the temperature necessary to produce satisfactory pasteurization; and if the system breaks down at any time and the material runs to the tank by gravity only, with no supplementary method of heating provided, of course no pasteurization of that day's whey is possible. This was found to occur occasionally.

By either method of treatment, approximately eight pounds of water is added, as steam, to each one hundred pounds of whey pasteurized. This dilution is not a serious defect; since the patrons lay more stress on quantity than on quality of product — a condition leading sometimes to the direct addition of considerable water to the whey in order that the last patrons may get their full share, even if the first ones take somewhat more than they should.

Conditions at factories.

At Factory A the whey was heated by direct steam in a half-buried tank outside the factory, after it had been siphoned out of the making vats onto the floor and had run through a trench in the floor and a buried pipe to the tank. It was the intention of the cheesemaker to heat the whey to at least 160° F.; but the readings of a recording thermometer in the tank, taken every day for nearly six weeks, showed that the temperature was usually higher than this and occasionally reached 178° F.

Though the tank itself was seldom cleaned and its sides were thickly scaled over, the whey was so well pasteurized by the heating that it appeared in good condition on each of the three days when samples were taken and had a clean, sweet smell very different from that of unpasteurized whey. The fat remained perfectly suspended in the tank, and the albumin, though curdled and tending to sink, was easily dipped out with the whey. Bacteriological analyses showed exceedingly satisfactory reduction in numbers, 150,000,000 per unit in the raw whey on one day being reduced to 51 in the pasteurized whey four and one-half hours later, 63,000,000 on the next day reduced to 700 three hours later, and 70,000,000 the third day falling to 6000 when the steam had been off forty-five minutes. The pasteurized whey, after standing all night in the tank, showed comparatively small numbers of the undesirable bacteria, which are active at ordinary open air temperatures; but contained very large numbers of an acid-producing form that finds its best condition for growth at or above body temperature and survives higher temperatures than most other bacteria. The presence of this organism was not revealed by the usual laboratory handling, but only after incubating the culture plates for two additional days at a higher temperature. The occurrence of this bacillus, *B. bulgaricus*, has undoubtedly often been overlooked, and its presence in such abundance is one of the surprises of this investigation. It produces a clean, rapid souring of milk which is not specially undesirable and which is necessary in making certain types of cheese. Its activity in the slowly cooling pasteurized whey checks the development of other less desirable germs.

At Factory B the whey was " jetted " twice, first from the making vat to a tank on the second floor, from which it ran by gravity to a fat separator, then to a barrel from which it was jetted to a wooden tub-tank outside. The whey cooled off rapidily in running through the pipes to this tank, particularly in cold weather, and separator slop, washings and added water were run into the whey tank, usually after the whey had cooled below the pasteurizing point. The tank was kept clean, the whey smelled sweet, and the albumin was not coagulated; so that, on the whole, the patrons were getting a much better product than before pasteurizing had been introduced. However, the temperatures used and held in the tank would not always insure destruction of the tubercle bacillus, nor was the reduction in the number of the other germs wholly satisfactory. The greatest reduction was only to 11,600 germs per unit after the whey had stood 30 minutes, and later the numbers rapidly increased again, especially when separator slop was added.

At Factory C conditions were much the same as at B, the whey being "jetted" twice and separator slop being added. The whey was also cooled quite rapidly by having to run a long distance through a pipe after the second " jetting ". The whey was undoubtedly improved for the patrons' use, but not as much as it would have been by thorough pasteurization; and danger of the spread of tuberculosis was not eliminated.

A Victor pasteurizer is used at Factory D. This is a small, horizontal, metal cylinder into which live steam is admitted and mixes with the whey as it passes through. The whey is " jetted " from the making vat to a fat separator and then passes through the pasteurizer, in which the temperature can be readily controlled. Very satisfactory germ control *could* easily be secured; but the whey flows by gravity to a tank, in which it cools quite rapidly, after which the separator slop is added, making the destruction of disease germs very uncertain.

At Factory E and at Factory F, direct steam to the tank secures very satisfactory pasteurization of the whey. The process is aided in E by one "jetting" of the whey, but is handicapped by having the tank so far from the source of steam that much heat is lost by radiation. Reduction of the bacteria counts from over 50,000,000 to 2,000 or less were secured, the fat remained well suspended and the whey was in fine condition for feeding. At Factory F the raw whey was not so thoroughly seeded with bacteria as at E, and the final counts were reduced to the same satisfactory figures.

At Factory G, where conditions were about as at F, similar reduction in the number of the bacteria was secured on one day of the three when samples were taken, and the pasteurization was undoubtedly efficient on all three days, so far as disease germs are concerned. But on two days the whey from the making vat was very heavily seeded with *Bacillus bulgaricus*, which resists quite high temperatures and did not perish at the temperatures used — not exceeding 156° F. In consequence, the numbers of bacteria developing from pasteurized whey on plates carried for the added two days at high temperature were still in the millions. These bacteria, though souring the whey rapidly, did not give it any undesirable characteristics.

At an eighth factory a sample of old, unpasteurized whey was taken from a tank which looked and smelled like an old swill barrel — one that had never been cleaned. On this tank the fat had collected in a layer that could not be drawn off through the pump until it had become very unsightly and foul smelling. Samples of this whey gave counts of only 4,000,000 germs per unit on plates incubated as described for this investigation; but microscropic counts showed 1,500,000,000 *Bacillus bulgaricus* and 30,000,000 yeasts in addition to these.

Best method of pasteurizing whey.

The observations made and figures secured at the separate factories indicate clearly that the heating of whey in the distributing tank by direct steam is the most convenient, most reliable and most effective method of pasteurizing, as it is, also, the least expensive.

Pasteurizing skim milk.

At one of the skimming stations where pasteurization of skim milk was attempted, the results were far from satisfactory on the first day of testing, when the matter of temperature was left to the operator. A Reid flash pasteurizer was used and the temperature supposed to be secured was 160° F., but in reality it did not rise above about 152° F. and in two of the runs was less than 145°. By heating to

152° F. the bacteria count was reduced from 1,000,000 to 63,000; but the milk was pumped from the pasteurizer to the distributing tank and the pump and pipe were evidently so seeded with germs that a sample of the supposedly pasteurized milk, taken from this tank, showed a higher count than before pasteurizing. By runs at lower temperatures (143° and 144°) the counts were not reduced below 500,000; but the washing and heating of pump and pipe by the hot milk gradually disposed of some of their unfavorable influence, so that at the last test the count in the tank was lowest.

On the second day the temperature was raised, by request of the bacteriologist making the tests, and runs at 162° and 170° reduced the counts to 8,000 and 500, respectively, in the milk as it left the pasteurizer; while the counts were not high, even in the tank — especially not on the last run when the full effect of the flow of the hot milk through pump and pipes was shown.

In the second skimming station, the milk is heated in a tank by using a Wizard agitator, and the count was reduced from 616,000 to 43,000 by holding the milk at 155° F. for 30 minutes; and as the milk was promptly cooled to about 50° F. the count had not increased greatly when the milk was returned to the patrons 20 hours later.

By admitting live steam into the pipe through which the milk is pumped from the separator to the agitator tank the temperature was raised to between 175° and 180°, whereby the death of 98 per ct. of the bacteria was secured. The milk, drawn into an unwashed can at a temperature of 146° F., stood for 30 hours at a temperature of about 70° without souring.

So far as these studies show there are two general methods of pasteurizing skim milk satisfactorily: the holding process with subsequent cooling and returning of milk to patrons the following day, and the flash system.

The first is expensive because of the cost of equipment and cooling, and may give unsatisfactory results unless carefully controlled.

By the flash method of heating, a regular milk pasteurizer may be used, though somewhat expensive, or some simple arrangement may be adopted by which condensed steam is added directly to the milk. In either case the best results are secured when the milk is turned back immediately to the patrons and put in the cans at a temperature that will hold it above 145° for 30 minutes. This will destroy most of the bacteria in the can and the milk will remain in good condition for a considerable time. By prompt cooling on return to the farm the length of keeping can be extended.

GUIDE TO BUILDINGS AND GROUNDS.*

LAND.

The field experiments of the Station are carried out on two farms which are the property of the State and one leased farm, at Geneva; on two farms leased for grape culture, at Fredonia and at Urbana; on a leased orchard near Rochester; on a leased hop vineyard near Cooperstown, and on farms and orchards to the number of half a hundred or more distributed throughout the State, on which work is done in cooperation with the owners.

The main farm, on which most of the Station buildings are located, consists of two parcels, one of 126 acres south of North street and between Castle street on the east and Preemption road on the west, the other of 3 acres on the north side of Castle street. Adjoining the latter parcel on the east is the leased farm of 30 acres.

The new farm (Crittenden farm) of 86 acres corners on the main farm at the northwest.

BUILDINGS.

Coming from Geneva by way of Castle street, a small dwelling house (First Assistant's) just before the curve of Castle street to the north, is the first of the Station buildings. Following this are dwelling houses occupied, in order, by the Botanist, Horticulturist, Entomologist, Bacteriologist and Dairy Expert.

On the corner of Castle street and North street is the Director's residence, and, in succession toward the west, the Biological and Dairy Building, Administration Building and Chemical Laboratory. Across North street, northwest of the Administration Building, are a " Triple House " occupied by the Chemist, Agriculturist and Editor, and a small dwelling for the Engineer.

South of the Biological Building are the Forcing Houses; south of the Administration Building is a small stone building for storage, and west of this a carpenter and repair shop and a fruit-storage building.

The Horse Barn will be found to the southeast of the Administration Building, and south of this the Cattle Barn. The noteworthy features of, or in, the latter barn are the King ventilation system by which the air of the stables is kept pure; upright stave and horizontal hoop silos; feed storage bins arranged for convenience in filling and using; milking machine installation; general stable construction to secure sanitary conditions; and the dairy herd of 26 Jersey cows, more than half of which are the descendants of two dams.

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* A reprint of Circular No. 42, August 2, 1915.

South of the cattle barn is a manure shed, with cement floor and drainage tanks. An Ice House lies west of the Horse Barn, a large Tool and Implement Storage Building west of the Cattle Barn, and the Goat House west of the manure shed. Cornering on the Cattle Barn at the southwest is a covered exercise yard for the dairy herd.

The Poultry Houses are some distance southeast of the group of barns, on the bank of Castle Creek, which crosses the main Station farm, and supplies a small pond from which ice is cut. The poultry work consists mainly of experiments, with few breeds and comparatively small numbers of birds, at present to determine the importance of calcium in the food and of some other mineral nutrients, to ascertain certain principles of breeding, and to answer a number of feeding questions, among them the utilization and importance of coarse and succulent vegetable foods.

On the leased farm is one dwelling house and on the Crittenden farm two, for laborers, and on the latter a large barn for storing grain and hay.

LABORATORIES AND OFFICES.

In the Biological Building at the right of the entrance is the office of the Dairy Expert, and near it the rooms for dairy work. In the first of these will be found a large sink with hot and cold water and steam for cleansing utensils and a steam chest for sterilizing them; a large circular revolving churn and butter-worker; large and small table butter-workers; equipment for testing Babcock glassware; a four-compartment churn, cream separators of several types and a Danish continuous pasteurizer. Above the butter-making apparatus is a large brine tank with ammonia expansion coils for reducing temperature. Communicating with this room is a large storage closet also provided with tanks and pipes for refrigeration. In a smaller room adjacent are different forms of Babcock fat testers, and in the large room at the rear tanks and presses for cheesemaking. On the floor above, on the same side of the building, are four refrigerator-construction rooms for cold-curing cheese, in which temperature can be maintained automatically, with a variation of little more than a degree, at any point between freezing and ninety degrees.

On the left side of the first floor are the rooms of the Horticultural Department, that of the Horticulturist nearest the entrance. These are mainly office rooms, though one is equipped with the necessary laboratory outfit for studies in fruit breeding and fruit growing. Here fruit identifications are made and the notes are filed for the monographs published, and to be published, by the Station on apples, grapes, plums, cherries, etc., and for the bulletins on development, cultivation, training and general management of fruits and vegetables. Among books belonging to the Station library but filed in this Department are many most interesting treatises on fruits, some of them very old and rare. Wax models of apples and grapes are shown in museum cases.

On the second floor of this building, on the west, are the offices of the Bacteriologist and his assistants and the laboratory for the study of these minute forms of life. The interesting pieces of apparatus in these rooms are dust-proof chambers for making inoculations, cultures and transfers of bacteria; steam and dry sterilizers for utensils and culture media, and culture chambers with automatic temperature control. The subjects receiving most attention in this department are sanitary dairying and the relation of dairy score cards to it; problems of the milking machine; the effect of stable conditions on milk quality, and the life and changes of bacteria in the soil with reference to the maintenance of fertility. In connection with the latter line large tiles set in the ground southeast of the forcing houses are used.

In the hall between the Bacteriologist's office and that of the Botanist on the right are cases showing specimens of plant diseases, fungi, etc., which lie in the province of the Botanist. The lines receiving most attention in recent years, and at present, in the Botanical Department are studies of potato troubles; diseases of currants and clematis; winter injury and other physiological troubles of fruit trees; methods of eradicating dandelions on lawns, and seed testing. An interesting display of weed seeds will be found in the west room of the east wing. In this room, also, and in the one adjoining, are cases showing insects and their work, and insect breeding cases belonging to the Entomological Department, whose rooms are in the southeast quarter of this floor. The problems at present demanding most attention from the Entomologists are the control of pear psylla, borer and thrips, apple and cabbage aphids, and maggots on cabbage and radish, and studies on sulphides as spray materials.

In the third story of this building are rooms for photographic work, and the brine tanks for the refrigeration system; and in the basement the boilers, engines, motors and pumps, with the fire-protection apparatus of the institution.

In the Administration Building are located the main office, Director's office and office of the Mailing Clerk on the first floor; and the Library and office of Editor and Librarian on the second floor. The rooms on the third floor are private, being occupied as dormitories by some of the Station employees. For bulletins, consult the Mailing Clerk in the rear room, west side, of main floor.

In the Chemical Laboratory will be found, on the first floor at the left, the office of the Chemist; at the right, the chemical library and reading room; and in the rear, at left and right, respectively, laboratories for dairy research and nutrition investigations. The basement laboratories are largely devoted to the analyses of fertilizers, feeding stuffs and insecticides and fungicides. The nitrogen determinations are made in the west laboratory, those of phosphoric acid in fertilizers and of fat or oil in feeds in the one at the east.

The laboratories are equipped with the various kinds of apparatus needed for the work, such as delicate balances, capable of weighing accurately less than 1-1000 grain; steam and electric drying-ovens; polariscope for quick determination of sugar; electric centrifugal machine whirling over 2000 revolutions a minute; special apparatus for determining fat or oil in feeds and other materials; special apparatus for determining nitrogen in any material.

On the second floor are the offices of the First Assistant, who has charge of poultry investigations, and of the Agronomist, whose time is given largely to problems of soil fertility, especially in orchards and vineyards, and in alfalfa growing.

The lysimeters or soil tanks, just west of the fruit-storage building, are part of the equipment for this department.

EXPERIMENTS IN PROGRESS.

On the lawn back of the Administration Building is a dandelion-spraying experiment, in which a fair degree of success has been secured in controlling this pest.

On the soil tanks west of the fruit-storage building, crops are growing in soils typical of certain sections of the State. This battery of twenty lysimeters makes it possible to secure very exact knowledge of the soil composition and of the changes made in it by the growth of various crops. The water draining from these tanks is all saved, measured and examined chemically.

Across the road from the Administration Building is a plantation of 975 seedling apple trees, each from known parents; interplanted among these are seedling gooseberries, currants and raspberries; and to the east lie six rows containing 950 seedling grapes.

East of the grapes, along the road, is a collection of about 600 varieties of dahlias.

In the first, or north, forcing house studies on plant nutrition are carried on, including pot tests of alfalfa and other crops on soil from the " hill lands " of southern New York and on soil from the Station farm, and of peaches grown with various fertilizer combinations.

In the other adjoining houses breeding work is being carried on with roses and orchids, and with cucumbers, melons and other vegetables. The east glass house is devoted to work with insects and plant diseases.

East of the forcing houses will be found a block of 600 seedling grapes, interspersed among which are 75 named Vinifera grapes, the first collection of these European grapes to be grown successfully in the open in the eastern United States. These varieties are marked with aluminum labels. Beyond the grapes is a block of named varieties of strawberries, and across the drive from them a collection of 60 varieties of English and American gooseberries. West of these are 30 varieties of currants, red, white and black, and 120 varieties of raspberries and blackberries. Then follow a block of seedling strawberries on their second test, two rows of grape seedlings and another block of seedling strawberries on their first test.

In the garden the only feature of special note is three rows of French, or globe, artichokes.

In vineyard 8, south of the garden, are 180 named varieties of grapes; east of this vineyard 325 seedling raspberries on their second test, with interset rows of seedling strawberries on their second or third testing; and still further to the east are other seedling strawberries on their first or second test. At the end of this block is a small orchard of dwarf apples.

The block across the drive south of the plats just mentioned extending from Castle street to the farm lane, contains only seedlings. The vineyard at the east end contains 3700 seedling grapes, interplanted with seedling raspberries on their first test. The raspberry plants remaining are survivors of full rows, the others having been discarded after fruiting.

The block of seedling apples, pears and plums west of the grape seedlings contains 700 trees, interspersed with raspberries on the east, and gooseberries on the west. The purple raspberries are hybrids between black and red raspberries.

South of this block of seedlings is the Station alfalfa field, part of it now turned under for a crop of beets; at the west end of this field is another vineyard of 70 named varieties of grapes.

Across Castle Creek, to the right of the drive is the Rome Beauty orchard, used for 20 years in a fertilizer test. The plat treatments are shown on labels at the north end of the rows. Trees of many other varieties are interspersed among the Rome Beauty trees.

Back of this orchard is a plantation of 960 Seckel pear pure seedlings, bred in the attempt to secure, if possible, a larger Seckel, and one resistant to blight.

East of the drive is a plum orchard of 275 varieties and south of this is a cherry plantation of 75 varieties. Back of the plums and cherries is an orchard containing 400 peaches, apricots and nectarines, with a block of native and Vinifera grapes at the north.

Beyond the orchards, to the south, are several experiments with field crops. First on the right are fertilizer and lime tests on alfalfa, with incidental trials of varieties and an experiment with alfalfa grown in rows to ascertain the chances for seed production in New York State.

South of the alfalfa is a twelve-acre field devoted to a comparison between manure and commercial fertilizers, both alone and in combination with green-manuring legumes. Four four-year rotations of crops have already been grown. Across the drive from this field are several experiments with potatoes: Test of time planting, by the Agronomist; the effect of spraying with sulphides either with or without arsenate of lead, by the Entomologist; and a comparison of lime-sulphur and bordeaux mixture, a test of thick and thin planting, and a field study of potato degeneration, by the Botanical Department.

Near the south side of the farm, east of the drive, are several experiments with soil in the open field, originally planned to study the effect of adding calcium and sulphur from different salts to a type of soil possibly lacking in absolute amount of these elements or in the best relative proportion of these constituents to others. Chemicals have been added to soil used in these experiments gradually for twenty to twenty-five years to get a cumulative change without too sudden disturbance of normal soil life; and various crops have been grown on the plats.

Coming back toward the buildings, the visitor finds to the west of the barns the remains of the old variety orchard of apples, of which the trees on the west half have been removed and the ground replanted to peaches, apricots and nectarines.

In this orchard, in the seedling orchard across from the Administration Building and in the Rome Beauty orchard spraying experiments for the control of pests are being conducted, this year with special reference to the rosy apple aphis.

West of the Ice House is a small nursery and west of this are seedling and named strawberries, on their final test on Station grounds. Beyond the tennis court is a second plantation of pure seedling Seckel pears, interset with gooseberries and raspberries and beyond these are apple and plum seedlings, with a few trees left of an old plum and pear orchard.

South of the drive and toward the west entrance are tests with vegetables, including breeding and selection trials of tomatoes, potatoes, cabbage, etc.

Passing now to the Crittenden farm, we find an irregular area on the south for general farm crops, and north of this a large field, newly underdrained, devoted to rotation and cultural experiments looking to the maintenance of soil fertility. A portion of the triangular area between this field and the main drain has been dynamited to test the effect of this operation on subsequent crops. Another dynamiting test in connection with fruit growing was made near the north end of the orchard on this farm.

This orchard, of about 30 acres, in the northwest section of the farm, contains about 3000 trees — apple, pear, plum, cherry and quince. It is primarily a variety orchard, but also used for experiments in testing effect of various methods of preliminary soil preparation, of different times and ages for planting, of methods of propagation, of influence of selected buds and of different stocks and of methods and times of pruning.

PERIODICALS RECEIVED BY THE STATION.

Acclimitation	Complimentary
Agricultural Epitomist	Complimentary
Agricultural Gazette of Canada	Complimentary
Agricultural Gazette of New South Wales	Complimentary
Agricultural Journal, China	Complimentary
Agricultural Journal of the Union of South Africa	Complimentary
Agricultural News	Complimentary
Agricultural Students' Gazette	Complimentary
Allegan Gazette	Complimentary
American Agriculturist	Subscription
American Chemical Society Journal	Subscription
American Cultivator	Complimentary
American Entomological Society, Transactions	Subscription
American Fertilizer	Subscription
American Florist	Subscription
American Food Journal	Complimentary
American Grocer	Complimentary
American Hay, Flour and Feed Journal	Complimentary
American Journal of Botany	Subscription
American Journal of Physiology	Subscription
American Miller	Complimentary
American Naturalist	Subscription
American Philosophical Society, Proceedings	Complimentary
American Poultry Advocate	Complimentary
American Society of Agronomy	Subscription
Analyst	Subscription
Annales de l'Institut Pasteur	Subscription
Annales de la Societe Entomologique de Belgique	Complimentary
Annales Mycologici	Subscription
Annals and Magazine of Natural History	Subscription
Annals of Applied Biology	Subscription
Annals of Botany	Subscription
Annals of the Missouri Botanical Garden	Subscription
Archiv der Gesammte Physiologie (Pflueger)	Subscription
Archiv fuer Hygiene	Subscription
Association belge des Chimistes, Bulletin	Complimentary
Berichte der deutschen botanischen Gessellschaft	Subscription
Berichte der deutschen chemischen Gessellschaft	Subscription
Better Fruit	Complimentary
Bibliographia Zoologica	Subscription
Biedermann's Zentralblatt fuer Agrikultur Chemie	Subscription

Biochemical Bulletin..............................
Biochemische Zeitschrift...........................
Biological Bulletin...............................
Biologisches Centralblatt..........................
Blooded Stock....................................
Boletim de Agricultura............................
Boletim do Instituto Agronomico....................
Boletin de la Sociedad Nacional de Agricultura.........
Boston Society of Natural History, Proceedings.........
Botanical Gazette.................................
Botanisches Centralblatt...........................
Bulletin de l'Institut Pasteur.......................
Bulletin fuer Angewandte Botanik....................
Caledonia Era.....................................
California Academy of Sciences, Proceedings............
California Cultivator..............................
California Fruit News.............................
California University Publications — Agricultural Scienc and Zoology.................................
Canadian Entomologist............................
Canadian Horticulturist...........................
Centralblatt fuer Bakteriologie, etc....................
Chemical Abstracts...............................
Chemical Society, Journal..........................
Chemisches Centralblatt...........................
Chicago Daily Farmers' and Drovers' Journal............
Chicago Dairy Produce............................
Cold..
Cold Storage and Ice Trades Review..................
Colman's Rural World.............................
Colonial Dairy Produce Report.....................
Columbus Horticultural Society Journal................
Commercial Poultry...............................
Country Gentleman................................
Country Life in America...........................
Country World....................................
Creamery and Milk Plant Monthly....................
Criador Paulista..................................
Dairy and Produce Review..........................
Denver Field and Farm............................
Deutsche Entomologische Zeitschrift..................
Deutschlands Obstsorten...........................
Duroc Bulletin...................................
Dry Farming......................................
Elgin Dairy Report...............................
Entomological News..............................
Entomological Society of America, Annals.............

Entomological Society of Washington, Proceedings	Subscription
Entomologische Mitteilungen	Complimentary
Entomologist	Subscription
Entomologists' Record	Subscription
Facts About Sugar	Complimentary
Farm and Fireside	Complimentary
Farm and Live Stock Journal	Complimentary
Farm and Orchard	Complimentary
Farm and Stock	Complimentary
Farm Engineering	Complimentary
Farm Journal	Complimentary
Farm Life	Complimentary
Farm News	Complimentary
Farm Poultry	Complimentary
Farm, Stock and Home	Complimentary
Farm Stock Success	Complimentary
Farmers' Advocate	Complimentary
Farmers' Digest	Complimentary
Farmers' Guide	Complimentary
Farmers' Voice	Complimentary
Farmer's Wife	Complimentary
Feathered World	Subscription
Field, The, Illustrated	Complimentary
Florists' Exchange	Subscription
Flour and Feed	Complimentary
Fruit Grower	Complimentary
Fruit and Produce Marketer	Complimentary
Garden	Subscription
Gardeners' Chronicle	Subscription
Gartenwelt	Subscription
Gas and Oil Power	Complimentary
Gleanings in Bee Culture	Complimentary
Grape Belt, The	Complimentary
Green's Fruit Grower	Complimentary
Hartwick Seminary Monthly	Complimentary
Harvester World	Complimentary
Hawaiian Forester and Agriculturist	Complimentary
Herd Register	Complimentary
Herkimer County News	Complimentary
Hoard's Dairyman	Complimentary
Holstein-Friesian Register	Complimentary
Holstein-Friesian World	Complimentary
Homestead	Complimentary
Hospodar	Complimentary
Hygienische Rundschau	Subscription
Indiana Farmer	Complimentary
Insect World (Japanese)	Complimentary

Internationale Mitteilungen fuer Bodenkunde	Subscription
Jahresbericht der Agrikultur-Chemie	Subscription
Jahresbericht Garungs-Organismen	Subscription
Jahresbericht der Nahrungs-und Genussmittel	Subscription
Jahresbericht Pflanzenkrankheiten	Subscription
Jahresbericht der Tier-Chemie	Subscription
Journal fuer Landwirtschaft	Subscription
Journal of Agricultural Research	Complimentary
Journal of Agricultural Science	Subscription
Journal of Agriculture, Victoria	Complimentary
Journal of Biological Chemistry	Subscription
Journal of Board of Agriculture (English)	Complimentary
Journal of the College of Agriculture, Tokyo	Complimentary
Journal of the Department of Agriculture of South Australia	Complimentary
Journal of the Department of Agriculture of Victoria	Complimentary
Journal of the New Zealand Department of Agriculture	Complimentary
Journal of Economic Biology	Subscription
Journal of Experimental Medicine	Subscription
Journal of Experimental Zoology	Subscription
Journal of Genetics	Subscription
Journal of Heredity	Subscription
Journal of Home Economics	Subscription
Journal of Hygiene	Subscription
Journal of Industrial and Engineering Chemistry	Subscription
Journal of Pathology and Bacteriology	Subscription
Journal of Physiology	Subscription
Just's Botanischer Jahresbericht	Subscription
Kimball's Dairy Farmer	Complimentary
Konigleichen Bayerische Akademie der Wissenschaften: Sitzungsberichte der Math.— Phys. Classe	Subscription
Land, The	Complimentary
Lanswirtschaft-Historische Blätter	Complimentary
Landwirtschaftliche Jahrbucher	Subscription
Landwirtschaftlichen Versuchs-Stationen	Subscription
Lewiston Orchards Life	Complimentary
Live Stock and Dairy Journal	Complimentary
Live Stock Report	Complimentary
Long Island Democrat	Complimentary
Maandblad der Nederlandsche Pomologische Veeriniging	Complimentary
Market Growers' Journal	Complimentary
Memoirs of the Department of Agriculture in India	Complimentary
Metropolitan and Rural Home	Complimentary
Michigan Farmer	Complimentary
Milchwirtschaftliches Zentralblatt	Subscription
Minnesota and Dakota Farmer	Complimentary
Mirror and Farmer	Complimentary
Modern Farming	Complimentary

Monthly Bulletin, International Institute of Agriculture	**Complimentary**
Monthly Bulletin of the N. Y. State Department of Health	**Complimentary**
Monthly Weather Review	**Complimentary**
Mycologia	**Subscription**
National Nurseryman	**Complimentary**
National Farmer (German)	**Complimentary**
National Farmer and Stock Grower	**Complimentary**
National Stockman and Farmer	**Complimentary**
Naturaliste Canadienne	**Complimentary**
Nebraska Farmer	**Complimentary**
New York Academy of Science, Annals and Transactions	Subscription
New York Botanical Garden, Bulletin	Complimentary
New York Entomological Society, Journal	Subscription
New York Farmer	Complimentary
New York Fruit and Produce News	Complimentary
New Zealand Dairyman	Complimentary
North American Horticulturist	Complimentary
North Fort Worth Sunday News	Complimentary
Northwest Pacific Farmer	Complimentary
Nut Grower	Complimentary
Ohio Farmer	Complimentary
Ohio Journal of Science	Subscription
Oklahoma Farm Journal	Complimentary
Pacific Coast Fanciers' Monthly	Subscription
Pacific Northwest	Complimentary
Pacific Fruit World	Complimentary
Parasitology	Subscription
Pennsylvania Farmer	Complimentary
Photo-Miniature	Subscription
Phytopathology	Subscription
Popular Agriculturist (Chinese)	Complimentary
Poultry	Complimentary
Poultry Herald	Subscription
Poultry Item	Complimentary
Poultry Keeper	Complimentary
Poultry Monthly	Complimentary
Power and Engineer	Subscription
Practical Farmer	Complimentary
Praktische Blaetter	Subscription
Profitable Breeding and Farming	Complimentary
Progressive Farmer	Complimentary
Profitable Farming	Complimentary
Psyche	Subscription
Quarterly Journal	Complimentary
Recreation	Subscription
Rabenhorst's Kryptogamen-Flora	Subscription
Reliable Poultry Journal	Subscription

Review of Applied Entomology	Subscription
Revista Industrial y Agricola de Tucuman	Complimentary
Revue de Viticulture (For Vineyard Laboratory, Fredonia, N. Y.)	Subscription
Revue Generale de Botanique	Subscription
Revue Horticole	Subscription
Riqueza Agricola	Complimentary
Royal Agricultural Society Journal	Subscription
Royal Botanic Gardens, Edinburgh, Notes	Complimentary
Royal Horticultural Society Journal	Complimentary
Rural Life	Complimentary
Rural New Yorker	Subscription
Salt Lake Herald	Complimentary
Saint Louis Academy of Science, Transactions	Complimentary
Sanitary Inspector	Complimentary
Science	Subscription
Scientific American	Subscription
Scientific Roll, Bacteria	Subscription
Seed World	Complimentary
Skaneateles Democrat	Complimentary
Smallholder, The	Complimentary
Societe Entomologique Belgique, Annales	Complimentary
Societe Entomologique de France, Bulletin	Complimentary
Societe Mycologique de France, Bulletin	Subscription
Southern Planter	Complimentary
Southern Farm Magazine	Complimentary
Southwestern Farmer and American Horticulturist	Complimentary
Southwestern Farmer and Breeder	Complimentary
Southwestern Stockman, Farmer and Feeder	Complimentary
Stazione Sperimentale Agrarie Italiane	Complimentary
Student Farmer, The	Complimentary
Successful Farming	Complimentary
Suffolk Herald	Complimentary
Texas Stockman and Farmer	Complimentary
Torrey Botanical Club, Bulletins and Memoirs	Subscription
Transvaal Agricultural Journal	Complimentary
Trucker and Farmer	Complimentary
Utica Semi-Weekly Press	Complimentary
Vertical Farming	Complimentary
Wallace's Farmer	Complimentary
West Virginia Farm Review	Complimentary
Western Fruit-Grower	Complimentary
Western Plowman	Complimentary
Wilson Bulletin	Complimentary
Wisconsin Natural History Society, Bulletin	Complimentary
Zeitschrift fuer Analytische Chemie	Subscription
Zeitschrift fuer Biologie	Subscription
Zeitschrift fuer Botanik	Subscription

Zeitschrift für Fleisch- und Milch-hygiene	**Subscription**
Zeitschrift fuer Hygiene und Infektionskrankheiten	**Subscription**
Zeitschrift fuer Induktive Abstammungs- und Vererbungslehre	**Subscription**
Zeitschrift fuer Pflanzenkrankheiten	**Subscription**
Zeitschrift fuer Pflanzenzuchtung	**Subscription**
Zeitschrift fuer Physiologische Chemie	**Subscription**
Zeitschrift für Untersuchung der Nahrungs- und Genussmittel	**Subscription**
Zeitschrift fuer Wissenschaftliche Insektenbiologie	**Subscription**
Zentralblatt fuer Biochemie und Biophysik	**Subscription**
Zoological Record	**Subscription**
Zoologischer Anzeiger	**Subscription**

METEOROLOGICAL RECORDS

METEOROLOGICAL RECORDS FOR 1915.

READING OF THE STANDARD AIR THERMOMETER.

DATE.	JANUARY.			FEBRUARY.			MARCH.			APRIL.			MAY.			JUNE.		
	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.
1	14.	24.	24.	30.	22.	20.	17.	30.	34.	32.	37.	39.	44.	48.	49.	62.	70.	77.
2	26.	20.	24.	15.	16.	24.	30.	36.	30.	32.	37.	39.	49.	56.	54.	60.	69.	69.
3	14.	16.	15.	12.	15.	12.	14.	18.	18.	29.	37.	36.	45.	51.	51.	54.	61.	65.
4	16.	30.	25.	14.	21.	23.	14.	28.	29.	31.	43.	46.	44.	48.	50.	60.	74.	77.
5	22.	34.	33.	28.	34.	34.	18.	32.	37.	35.	38.	44.	45.	54.	56.	61.	78.	82.
6	39.	39.	44.	39.	37.	37.	30.	36.	36.	42.	54.	47.	52.	64.	68.	61.	77.	80.
7	42.	40.	36.	31.	31.	30.	32.	36.	36.	39.	46.	52.	52.	63.	65.	71.	81.	81.
8	31.	30.	29.	20.	25.	25.	27.	31.	30.	45.	58.	63.	58.	66.	72.	57.	66.	68.
9	26.	27.	27.	15.	15.	12.	25.	36.	35.	41.	67.	73.	50.	48.	50.	59.	68.	65.
10	25.	31.	29.	12.	21.	21.	28.	36.	34.	56.	76.	65.	49.	60.	64.	55.	64.	65.
11	26.	34.	36.	30.	42.	40.	30.	34.	31.	56.	64.	57.	56.	68.	72.	59.	75.	80.
12	30.	31.	32.	40.	37.	34.	19.	28.	29.	44.	46.	40.	60.	75.	72.	58.	71.	73.
13	25.	25.	26.	13.	34.	34.	25.	40.	43.	36.	43.	44.	57.	54.	50.	68.	81.	86.
14	22.	35.	35.	37.	41.	40.	30.	40.	38.	41.	50.	50.	49.	58.	59.	65.	77.	77.
15	33.	36.	33.	39.	41.	39.	30.	33.	37.	41.	57.	56.	46.	58.	58.	65.	79.	65.
16	24.	35.	34.	33.	32.	32.	25.	35.	31.	39.	45.	44.	41.	43.	44.	66.	72.	77.
17	26.	40.	40.	26.	27.	27.	23.	26.	27.	37.	47.	49.	47.	48.	51.	70.	81.	75.
18	33.	33.	33.	13.	27.	25.	20.	33.	36.	46.	62.	62.	45.	53.	50.	65.	79.	86.
19	37.	35.	31.	14.	35.	36.	25.	42.	40.	58.	71.	74.	45.	55.	59.	74.	68.	78.
20	26.	31.	29.	19.	44.	46.	23.	40.	39.	55.	65.	62.	50.	56.	58.	58.	65.	66.
21	18.	23.	18.	25.	48.	47.	30.	34.	34.	39.	50.	57.	51.	59.	57.	63.	72.	72.
22	9.	15.	12.	36.	50.	46.	32.	37.	36.	49.	56.	58.	62.	68.	70.	64.	67.	56.
23	35.	32.	25.	39.	50.	50.	34.	46.	44.	42.	64.	70.	53.	56.	58.	50.	50.	52.
24	10.	21.	19.	44.	51.	43.	32.	43.	45.	53.	75.	80.	48.	57.	64.	53.	64.	70.
25	21.	34.	20.	37.	38.	35.	37.	48.	43.	79.	86.	88.	54.	70.	70.	57.	71.	71.
26	17.	27.	26.	18.	20.	20.	24.	23.	23.	66.	86.	86.	55.	46.	47.	65.	74.	76.
27	34.	35.	28.	15.	19.	20.	23.	33.	35.	66.	82.	67.	45.	55.	60.	64.	72.	71.
28	23.	24.	20.	15.	25.	25.	30.	44.	42.	61.	78.	63.	55.	63.	60.	65.	78.	79.
29	9.	16.	11.	....	....	....	17.	26.	27.	64.	67.	66.	59.	65.	60.	67.	80.	81.
30	—2.	15.	11.	....	....	....	16.	16.	30.	49.	58.	50.	49.	65.	69.	64.	67.	68.
31	17.	23.	30.	....	....	....	21.	30.	32.	....	....	....	63.	73.	73.	....	....	.....
Averages	23.5	20.	26.9	25.3	32.1	31.3	25.2	34.	34.2	47.1	58.2	57.6	50.9	58.2	59.4	62.	71.7	72.9

READING OF THE STANDARD AIR THERMOMETER (*concluded*).

DATE.	JULY.			AUGUST.			SEPTEMBER.			OCTOBER.			NOVEMBER.			DECEMBER.		
	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.
1	64.	69.	78.	74.	85.	85.	52.	71.	74.	46.	57.	52.	56.	68.	58.	29.	39.	35.
2	67.	77.	66.	71.	84.	78.	56.	79.	81.	50.	53.	49.	46.	55.	44.	31.	32.	33.
3	66.	77.	64.	66.	64.	60.	63.	78.	79.	50.	58.	59.	37.	44.	40.	28.	32.	29.
4	65.	72.	76.	62.	72.	69.	64.	80.	79.	52.	68.	71.	37.	41.	38.	23.	28.	26.
5	61.	68.	69.	64.	82.	80.	65.	75.	72.	57.	59.	56.	40.	38.	37.	26.	26.	25.
6	55.	67.	69.	63.	70.	68.	66.	72.	70.	45.	50.	49.	34.	39.	38.	27.	30.	30.
7	65.	69.	67.	62.	73.	75.	67.	75.	75.	43.	57.	56.	31.	45.	44.	27.	27.	29.
8	59.	60.	67.	65.	79.	63.	67.	84.	83.	48.	55.	52.	40.	55.	54.	31.	38.	37.
9	63.	74.	76.	64.	75.	76.	75.	87.	85.	40.	47.	45.	46.	48.	44.	26.	24.	22.
10	65.	81.	80.	64.	75.	78.	69.	79.	77.	39.	45.	46.	32.	45.	41.	19.	23.	21.
11	63.	74.	67.	68.	81.	80.	69.	72.	73.	42.	60.	63.	40.	48.	45.	17.	27.	23.
12	65.	73.	76.	68.	70.	67.	66.	74.	73.	49.	69.	66.	55.	51.	46.	14.	27.	24.
13	69.	82.	68.	71.	77.	75.	68.	83.	68.	52.	68.	67.	42.	49.	44.	26.	32.	33.
14	73.	84.	85.	70.	77.	81.	75.	86.	86.	61.	68.	65.	32.	44.	45.	26.	25.	21.
15	70.	84.	80.	66.	75.	81.	75.	88.	82.	52.	61.	54.	40.	41.	34.	17.	24.	26.
16	69.	79.	86.	72.	83.	83.	72.	86.	88.	50.	56.	55.	30.	36.	34.	27.	28.	25.
17	74.	83.	81.	58.	70.	68.	73.	73.	69.	42.	60.	62.	31.	36.	31.	31.	34.	36.
18	67.	73.	80.	56.	68.	69.	59.	72.	72.	49.	61.	62.	24.	40.	43.	34.	34.	34.
19	70.	83.	69.	68.	72.	75.	63.	71.	70.	58.	63.	63.	41.	52.	45.	32.	34.	33.
20	66.	70.	75.	68.	75.	75.	57.	70.	70.	50.	71.	66.	37.	39.	37.	21.	29.	26.
21	66.	72.	73.	65.	66.	68.	56.	57.	55.	58.	59.	55.	36.	37.	35.	23.	29.	24.
22	67.	74.	68.	65.	71.	69.	46.	58.	58.	44.	54.	53.	31.	36.	32.	25.	34.	37.

READING OF MAXIMUM AND MINIMUM THERMOMETERS FOR 1915.

DATE.	JANUARY.		FEBRUARY.		MARCH.		APRIL.		MAY.		JUNE.	
	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.
1	27.	13.	35.	19.	35.	11.	41.	31.	52.	43.	80.	44.
2	32.	23.	25.	15.	38.	28.	39.	31.	58.	44.	77.	52.
3	25.	13.	25.	11.	32.	14.	39.	24.	54.	34.	69.	51.
4	34.	11.	26.	11.	30.	12.	47.	26.	53.	34.	78.	41.
5	40.	20.	35.	20.	38.	15.	46.	23.	59.	42.	83.	43.
6	44.	28.	45.	33.	38.	28.	54.	39.	69.	44.	82.	42.
7	46.	36.	38.	30.	38.	30.	53.	38.	69.	45.	88.	57.
8	38.	28.	30.	20.	36.	24.	65.	33.	73.	50.	81.	53.
9	30.	25.	25.	11.	36.	21.	75.	38.	73.	45.	73.	41.
10	35.	25.	25.	10.	38.	28.	80.	53.	73.	34.	69.	50.
11	37.	23.	43.	19.	37.	28.	68.	45.	73.	46.	80.	53.
12	36.	30.	47.	34.	32.	17.	58.	39.	73.	46.	80.	51.
13	32.	25.	34.	13.	44.	23.	47.	31.	73.	46.	87.	48.
14	38.	13.	42.	34.	43.	27.	52.	26.	61.	40.	86.	62.
15	44.	30.	43.	37.	40.	23.	60.	27.	61.	38.	80.	55.
16	36.	22.	39.	32.	37.	21.	56.	32.	59.	36.	77.	51.
17	42.	32.	33.	25.	32.	21.	52.	33.	50.	42.	81.	61.
18	40.	32.	31.	12.	40.	17.	67.	44.	51.	36.	86.	49.
19	41.	31.	42.	14.	47.	20.	77.	50.	60.	36.	86.	66.
20	32.	25.	47.	19.	42.	23.	74.	51.	63.	39.	80.	57.
21	29.	18.	53.	19.	40.	28.	67.	31.	63.	39.	74.	45.
22	18.	9.	51.	31.	37.	31.	62.	34.	72.	44.	78.	56.
23	38.	12.	53.	27.	49.	30.	71.	49.	77.	50.	59.	48.
24	26.	9.	51.	42.	47.	32.	81.	49.	64.	42.	71.	46.
25	38.	19.	43.	34.	50.	35.	88.	59.	73.	42.	72.	50.
26	38.	5.	36.	12.	47.	20.	88.	59.	73.	42.	77.	51.
27	35.	15.	20.	13.	37.	18.	87.	62.	61.	34.	76.	49.
28	29.	20.	27.	15.	46.	25.	86.	56.	65.	43.	80.	47.
29	20.	6.	......	......	44.	15.	75.	56.	65.	60.	83.	53.
30	17.	—3.	......	......	32.	21.	67.	46.	69.	35.	81.	63.
31	30.	1.	......	......	33.	20.	......	......	74.	41.	......	......
Averages	33.8	19.2	37.3	21.9	30.2	22.8	64.1	40.5	64.9	40.4	78.1	51.2

SUMMARY OF AVERAGES OF MAXIMUM, MINIMUM AND STANDARD AIR THERMOMETERS FOR 1915.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum	33.8	37.3	39.2	64.1	64.9	78.1	80.5	77.7	76.4	61.9	48.4	33.8
Minimum	19.2	21.9	22.8	40.5	40.4	51.2	58.7	57.9	54.8	43.4	33.7	23.1
Standard 7 A. M.	23.5	25.3	25.2	47.1	50.9	62.	66.4	63.7	60.4	46.7	37.2	26.
Standard 12 M.	29.	32.1	34.	58.2	58.2	71.7	76.1	72.4	72.	56.6	44.8	30.5
Standard 5 P. M.	26.9	31.3	34.2	57.8	59.4	72.9	74.8	72.	70.6	55.5	41.3	29.3

MONTHLY MAXIMUM AND MINIMUM TEMPERATURES FROM 1883 TO 1915 INCLUSIVE (*continued*).

(Highest and Lowest Record for Each Month in Heavy Type.)

	MAY.				JUNE.				JULY.				AUGUST.			
	MAX.		MIN.		MAX.		MIN.		MAX.		MIN.		MAX.		MIN.	
	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.
1883	11	87.	1 & 14	31.	7	86.5	2	42.	5	89.	1	46.	23	92.	15	46.
1884	24	88.	30	32.	25	90.	15	41.	2	87.5	15	50.	20	95.	25	44.
1885	18	81.7	3	27.5	14	86.5	23	41.5	18	90.5	12	46.5	1	89.	28	45.
1886	23	79.5	17&18	37.2	14	86.2	1	42.2	7	95.	1	45.2	30	91.5	6	47.7
1887	23	88.2	14	37.5	17	89.2	15	47.7	3	95.5	11	58.7	3	88.5	8	46.
1888	13	79.8	3	29.	23	94.1	4	40.	5	89.8	16	47.	9	92.6	23	48.3
1889	18	91.8	29	32.	22	85.	5	46.	11	90.7	6	50.5	31	86.7	16&17	50.3
1890	4	80.7	2	30.	30	85.6	8	44.8	9	94.5	24	46.5	4	96.2	24	46.0
1891	11	85.5	4	29.5	16	95.	6	40.	14	92.	31	46.	12	92.	29	46.5
1892	31	78.	9	34.2	14	92.	11	45.8	29	96.3	2	46.4	10	95.5	28	49.
1893	25	88.	9	35.	21	94.	1	44.	26	95.5	24	48.4	11	94.5	13	49.
1894	2	85.4	14	32.6	23	91.6	6	39.	21	97.	10	49.6	25	93.	27	45.3
1895*	31	92.	13&21	36.	3	96.	7	54.	8	94.	11	52.	11	88.	22	44.
1896	11	87.5	7 & 20	40.	21	89.	3	41.	3	94.	18	49.	6 & 7	96.	29	44.
1897	24	80.	8	32.5	24&25	87.5	2	42.	11	97.	15	57.	15	87.5	21	46.
1898	29	79.	6	34.	9	90.	16	40.	4	96.5	12	40.	24	90.5	28	47.
1899	2	87.5	15	32.5	6 & 24	93.	11	41.5	4	97.5	1	50.	20	97.5	15	44.5
1900	15&16	88.5	7	27.	25	93.	10	45.	17	96.	1	50.	11	97.	2	51.
1901	23	78.	16	36.	27 28 & 29	95.5	2	42.	1	97.5	20	54.5	22	90.	5	52.
1902	22	90.	11	26.	3	85.	6	38.	14&27	90.	1	58.	31	90.	13	47.
1903	19	89.	2	24.	30	86.5	1	39.	9	94.	15	50.	18	85.5	8 & 14	45.
1904	25	88.	12	31.5	5–24 & 25	89.	12&17	45.	19	93.	3	49.	25	89.5	19	45.
1905	3	82.	2	29.5	19	90.	1	40.	18	92.	22	48.5	10	93.	27	41.
1906	24	88.5	11&21	30.	8	92.	12	37.	20–22 & 23	89.	25	50.	5	93.	16	47.
1907	14	85.	2–11 & 12	28.	18	94.	8	41.	16	90.	4	46.	12	96.5	19	41.5
1908	29	90.	1–4&5	31.	19	92.	12	43.	6–11 & 30	94.	9	52.	4	95.	25	46.
1909	31	78.	2 & 3	33.	28	90.	8	43.	15	92.	4	42.	8	98.	31	42.
1910	20	79.	16	31.5	22	89.9	4	36.	9	96.5	5	50.	3 & 15	90.	27	44.
1911	22	97.	3	27.	11	90.5	17	46.	5	105.0	25–26 & 27	50.	8	94.5	30	47.
1912	24	88.	14	34.	1	89.	8	40.	8 & 10	95.	1	41.	14	92.	17	44.
1913	4	91.	11	30.	30	92.	9	37.	1 & 4	95.	12	50.	17	98.	25&26	44.
1914	26&27	90.	1	34.	24&25	90.	20	39.	11	93.	4	50.	9	94.	26	47.
1915	23	77.	3 & 4 10&27	34.	18&19	86.	4 & 9	41.	31	90.	22&23	49.	1	89.	27	48.

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* Data from record kept by Mr. Edgar Parker for the year 1895; Station record not available.

MONTHLY MAXIMUM AND MINIMUM TEMPERATURES FROM 1883 TO 1915, INCLUSIVE (*concluded*).

(Highest and Lowest Record for Each Month in Heavy Type.)

	SEPTEMBER.				OCTOBER.				NOVEMBER.				DECEMBER.			
	MAX.		MIN.		MAX.		MIN.		MAX.		MIN.		MAX.		MIN.	
	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.
1883	17	80.	11	37.	11	78.	17&18	25.	22	70.	17	13.	9 & 14	56.	23	—7.5
1884	5	94.	14	26.	5	84.2	27	23.	11	62.	25	15.	31	55.5	20	—15.5
1885	27	83.7	24	40.	1	79.	13	25.	8 & 13	68.	28	18.	24	53.	9	4.
1886	11	89.5	22	49.	10	76.7	17	27.5	3	68.2	28	17.	11&25	46.	6	—6.
1887	22	81.7	27	37.2	9	78.5	31	21.2	28	68.	30	15.	12	54.7	2	—3.
1888	1 & 10	83.	7	40.	6	62.7	22	29.	1 & 3	73.	23	8.	27	53.	22	4.
1889	4	84.	22 & 23&29	40.	2	68.7	24	21.2	4	61.7	17	17.8	25	60.5	4 & 5	8.
1890	8	83.6	25	35.5	5	69.8	31	32.	8	65.4	28	17.	1	46.2	20	3.
1891	26	92.8	30	43.	4	89.4	12&25	27.	1	68.	29	12.	5	57.7	18	7.
1892	26	88.	20	39.	1	82.	2	33.1	19	60.	24	18.	9	49.2	27	—3.7
1893	5	80.	26	37.4	13	76.	31	25.	3	62.	27	19.	26	62.	14	1.5
1894	4	90.	26	33.	1	76.5	15	33.	3	65.	29	12.	17	59.	29	—0.2
*1895**	4	94.	15&30	42.	2	72.	30	28.	7	68.	21	19.	20&21	62.	13	—2.
1896	12	95.	23	36.	30	77.5	10&19	29.	19	70.	21	19.5	14	58.	28	2.
1897	11	98.	21	37.5	16	88.	10&18	30.	6	65.	24	16.5	12	61.5	24	2.
1898	4	94.	21	40.5	1	85.5	28	31.	5	63.	28	16.	31	54.	14	3.
1899	4	92.	15&30	30.	15	86.	3	26.	19	60.	14	25.	12	60.	31	—1.
1900	12	95.	19	37.	6 & 7	89.	20	28.	22	70.	17	19.	4	55.	10&14	4.
1901	6	89.	26	36.	10&11	74.	28	28.	1	65.	27	13.	14	62.	18	—1.
1902	1	90.	15	38.	19	74.	10 & 22&30	29.	14	73.	29	22.	2	52.	9	—5
1903	14	90.	29	35.	1	73.	25&27	[illegible]	[illegible]	[illegible]	[illegible]					
1904	[illegible]	[illegible]	[illegible]													

YEARLY MAXIMUM AND MINIMUM TEMPERATURES FROM 1883 TO 1915 INCLUSIVE.

(Highest and Lowest Record for THE TIME in Heavy Type.)

	MAXIMUM FOR EACH YEAR.		MINIMUM FOR EACH YEAR	
	Date.	Temp.	Date.	Temp.
1883	Aug. 23	92.	Jan. 11	— 9.
1884	Aug. 20	95.	Dec. 20	—15 5
1885	July 18	90.5	Feb. 11	—11.5
1886	July 7	95.	Jan. 13	—18.7
1887	July 3	95.5	Jan. 19	— 8.
1888	June 23	94.1	Feb. 10	— 7.
1889	May 18	91.8	Feb. 4 and 24	— 7.
1890	Aug. 4	96.2	Mar. 8	2.
1891	June 16	95.	Feb. 15	2.5
1892	July 29	96.3	Jan. 10	— 5.
1893	July 26	95.5	Jan. 11	— 6.
1894	July 21	97.	Feb. 27	— 8.5
1895*	June 3	96.	Feb. 8	—14.
1896	Aug. 6 and 7	96.	Feb. 17	**—21.**
1897	Sept. 11	98.	Jan. 20	— 3.5
1898	July 4	96.5	Jan. 30 and 31	— 4.
1899	July 4 and Aug. 20.	97.5	Feb. 11	— 8.
1900	Aug. 1	97.	Feb. 27	0.
1901	July 1	97.5	Feb. 24	2.5
1902	May 24, July 14 and 27, August 31 and Sept. 1	90.	Dec. 9	— 5.
1903	July 9	94.	Feb. 18 and Dec. 19.	— 4.
1904	July 19	93.	Feb. 16	—18.
1905	Aug. 10	93.	Feb. 5 and 14	— 6.
1906	Aug. 5	93.	Feb. 6 and 7	— 7.
1907	Aug. 12	96.5	Jan. 24	—18.
1908	Aug. 4	95.	Jan. 2 and 5	—14.
1909	Aug. 8	98.	Jan. 19	— 7.
1910	July 9	96.5	Jan. 5	— 8.
1911	July 5	**105.**	Jan. 5	— 1.
1912	Sept. 6	95.	Jan. 14	—12.
1913	Aug. 17	98.	Feb. 10	—10.
1914	Aug. 9	94.	Feb. 13 and 24	—14.
1915	Sept. 14	93.	Jan. 30	— 3.

* Data from record kept by Mr. Edgar Parker; Station record not available.

Average Monthly and Yearly Temperatures Since 1882.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Yearly averages.
1883	17.4	22.3	23.6	43.8	52.0	66.6	67.4	65.6	56.3	46.6	39.1	27.5	44.0
1884	17.6	28.3	29.5	40.7	54.3	67.1	66.5	69.9	65.2	50.5	36.5	27.2	46.1
1885	20.6	11.4	18.8	41.2	54.3	63.6	69.7	65.0	58.3	49.2	39.3	27.8	43.3
1886	19.6	22.9	30.2	48.1	55.7	64.0	68.0	67.5	61.8	49.6	36.8	22.2	45.5
1887	20.2	23.2	26.3	41.1	62.5	65.7	75.6	66.5	57.7	47.0	37.6	27.6	45.9
1888	16.4	22.8	24.6	40.8	54.3	66.5	66.8	68.0	62.2	43.9	39.4	29.3	44.6
1889	29.1	18.1	33.9	45.1	58.4	65.3	70.2	66.0	60.5	44.0	40.3	35.2	47.2
1890	31.2	30.9	28.8	44.2	52.3	67.1	69.5	67.7	60.1	49.3	87.6	21.4	46.7
1891	25.9	28.3	30.8	45.3	52.0	66.4	66.4	68.5	66.2	48.3	38.4	35.5	47.7
1892	21.4	25.9	26.5	43.5	52.8	68.6	70.2	69.4	61.2	50.0	35.9	25.2	45.9
1893	15.5	20.6	29.5	41.1	54.1	68.2	69.8	68.8	58.0	52.0	38.2	27.5	45.3
1894	29.7	20.6	38.9	44.1	55.5	67.8	74.2	66.8	64.9	52.7	36.0	81.5	48.6
1895	21.8	16.9	26.9	44.4	59.0	......	......	71.2	61.7	45.4	39.6	31.4	....
1896	22.4	24.1	24.4	49.3	62.0	65.9	71.4	70.0	60.2	56.5	42.9	27.1	48.0
1897	23.2	26.1	33.8	45.0	55.4	62.3	73.6	67.6	62.3	52.6	39.7	29.2	47.6
1898	26.2	26.8	......	43.2	57.0	67.7	74.2	71.0	65.9	52.1	37.9	27.9	....
1899	22.1	20.4	30.4	46.6	57.6	69.5	71.2	71.6	60.6	53.5	38.9	30.0	47.7
1900	26.0	22.6	23.6	43.5	56.7	68.4	72.6	74.1	66.1	57.9	41.1	28.7	48.4
1901	26.1	18.5	32.2	46.5	56.9	68.9	76.6	71.0	64.0	51.4	34.3	27.7	47.9
1902	23.2	22.2	39.5	46.6	56.1	63.2	71.2	67.6	53.6	43.1	46.3	25.7	47.4
1903	25.7	28.1	42.2	45.9	60.4	63.2	70.8	65.5	64.4	52.5	36.2	23.3	48.2
1904	18.9	23.1	30.9	41.4	60.3	67.8	70.0	68.2	61.9	48.4	36.9	22.5	45.9
1905	19.8	18.9	33.1	44.8	57.5	66.4	71.8	68.7	63.7	52.4	37.6	32.0	47.2
1906	32.5	26.1	27.6	46.4	57.5	68.2	71.4	72.8	67.3	51.2	37.9	26.1	48.8
1907	24.9	19.5	38.1	40.2	51.3	64.0	71.2	68.4	64.4	47.9	38.7	31.8	46.7
1908	25.9	21.3	34.6	44.8	59.2	68.8	73.4	68.8	67.0	52.9	40.0	29.2	48.8
1909	27.7	28.6	31.0	44.3	57.9	67.2	69.6	70.0	63.5	47.7	44.5	25.7	48.1
1910	25.1	22.1	42.1	50.1	54.9	65.2	73.1	69.0	63.2	53.1	35.7	21.5	47.9
1911	24.9	26.6	30.9	44.8	64.9	67.5	74.4	70.9	62.8	50.7	36.6	35.1	49.4
1912	15.9	21.6	28.2	45.1	58.9	64.3	73.2	68.6	68.4	53.5	42.5	33.9	47.8
1913	32.7	18.8	36.9	48.3	56.9	66.8	72.1	70.0	61.3	54.0	44.5	33.6	49.7
1914	25.4	17.7	31.7	43.4	60.2	67.3	59.9	70.5	61.4	55.4	39.2	26.0	46.5
1915	26.5	29.6	31.0	52.3	52.6	64.6	69.6	67.8	65.6	52.6	41.1	28.5	48.5
Monthly averages	23.7	22.9	31.0	44.7	56.7	66.4	70.8	68.9	62.5	50.5	38.9	28.3	47.1

Precipitation by Rainfall Only by Months Since 1882.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
1882	......	......	......	......	......	3.69	2.42	2.37	1.25	0.62	1.22	0.55	......
1883	0.48	1.44	0.88	1.58	4.45	4.12	2.98	3.47	2.12	2.10	1.54	0.73	25.89
1884	1.83	2.01	2.54	0.83	2.49	2.01	2.33	1.44	3.17	1.67	1.01	0.97	22.30
1885	1.07	0.61	0.12	1.26	1.58	2.49	4.64	5.02	2.11	2.88	1.36	0.76	23.90
1886	1.13	0.95	1.13	4.13	1.92	2.92	4.41	2.86	2.31	1.79	3.48	1.24	27.87
1887	0.18	2.97	0.48	1.37	0.46	2.01	6.37	3.03	0.75	1.74	1.58	1.35	22.29
1888	0.78	1.04	1.43	3.09	2.79	2.88	0.99+	4.02	2.73	3.47	2.02	1.24	20.48
1889	2.99+	0.25	0.66+	3.28	1.21	7.47	4.57	1.98	2.50	3.32	3.44	1.62	32.28
1890	2.16	1.45	2.16	2.20	5.49	4.26	1.07	4.34	5.81	4.54	2.40	......	36.88
1891	1.44	1.57	3.25	1.63	0.49	4.31	3.52	3.16	0.47	2.65	0.74	3.29	27.52
1892	0.57	0.88	0.55	0.67	4.04	3.95	1.89	4.77	1.12	1.34	1.67	0.72	28.17
1893	1.62	3.71	1.94	2.59	4.92	3.08	2.68	5.38	2.68	1.59	1.09	1.56	33.84
1894	2.21	2.71	1.36	2.43	7.03	1.77	1.50	1.22	4.64	3.59	0.43	0.47	29.36
1895	0.96	......	0.29	1.36	2.88	......	......	2.66	0.94	0.72	2.81	2.49	......
1896	1.19	2.28	0.84	0.41	2.31	3.71	4.12	3.33	4.27	2.26	2.18	0.71	27.61
1897	0.64	0.21	2.12	1.90	2.19	3.16	5.28	1.27	2.36	0.78	2.53	1.39	23.78
1898	1.74	0.33	1.54	2.03	1.90	2.37	1.32	3.60	1.86	3.83	2.03	0.33	22.90
1899	0.37	0.30	1.22	1.12	1.69	1.71	4.15	1.05	2.28	2.69	1.36	1.46	19.35
1900	1.43	2.42	0.02	0.95	1.71	1.45	6.53	1.75	0.91	3.65	6.13	0.78	27.73
1901	0.72	......	2.19	4.43	3.80	2.07	3.97	5.52	2.46	1.35	2.09	3.37	31.97
1902	0.86	0.66	1.94	1.92	2.84	4.33	5.29	2.41	2.88	2.82	0.74	0.74	26.89
1903	1.81	1.11	5.62	2.60	0.23	7.77	4.86	7.21	1.30	4.19	1.63	0.38	38.69
1904	0.80	1.03	2.41	1.67	4.04	3.37	5.73	2.56	3.26	2.06	0.26	1.42	28.61
1905	0.40	0.27	1.09	2.05	2.01	8.78	3.59	5.44	1.90	3.69	1.32	1.84	32.38
1906	1.46	0.53	1.60	2.08	4.24	5.31	2.87	3.68	2.16	3.56	1.40	1.54	29.93
1907	1.89	0.03	1.14	2.42	1.82	2.34	2.86	1.35	2.73	2.48	2.78	1.89	24.73
1908	0.68	1.12	1.24	3.28	3.57	1.96	4.72	1.79	1.66	2.73	0.88	0.43	24.06
1909	0.94	1.68	1.35	3.20	2.83	2.17	2.04	2.21	2.22	1.18	0.56	0.49	20.87
1910	0.87	0.53	0.28	4.56	3.45	1.55	2.39	5.47	3.29	1.73	0.62	0.38	25.12
1911	0.91	0.24	1.07	3.24	1.36	2.51	4.49	3.36	3.21	2.37	1.41	2.08	26.25
1912	0.20	0.95	1.92	3.41	7.27	2.09	4.85	2.21	5.89	1.42	1.48	1.13	32.82
1913	3.88	0.11	4.64	3.40	2.68	3.24	2.08	1.65	2.64	4.03	2.41	0.77	31.48
1914	0.98	0.15	1.28	3.10	4.00	2.69	2.18	6.05	1.62	1.55	1.08	1.18	25.81
1915*	2.67	1.77	0.65	0.64	2.41	2.57	2.44	5.90	1.78	4.44	2.03	4.06	†31.36
Monthly averages	1.22	1.12	1.57	2.32	2.93	3.36	3.50	3.26	2.47	2.42	1.73	1.28	27.31

* Beginning with 1915, the precipitation in snowfall as well as rainfall is given: the snowfall being reduced to its equivalent in rainfall and added to it.

† Of which 25.70 inches came as rain.

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